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ABSTRACT

This research described the classroom implementation of a supplemental activities-based mathematics project designed for low-achieving students. The research describes the development of applied ethnographic methods for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. A model for use by school district evaluators in conducting ethnographic evaluation studies was developed. The research consisted of ethnographic observations of mathematics lessons and student learning in nine classrooms in Grades 2 through 5 in eight schools serving low-income attendance areas. Observations were conducted over approximately a five-week period by four trained ethnographic assistants. Observations were scheduled before, during and following the delivery of classroom services of Mathematics Project Specialists. Themes emerging from the study indicated that the predominance of classroom structure, the conditional nature of classroom teacher-resource teacher collaboration, teacher inservice, and teacher's evaluations of subsequent student achievement growth were key factors in program implementation. Ethnographic descriptions of mathematic classroom activity structures provided a number of insights into the contribution of mathematic games and other manipulative aids to the learning of low-achieving students. The final report is subdivided as follows: (1) Abstract, Executive Summary, Addendum; (2) Part one, "An Ethnographic Evaluation of Program Implementation"; (3) Part two, "Mathematics Learning of Low Achieving Students through Mathematics Games and Other Manipulative Aids"; and (4) Part three, "Eight Disaggregated Case Studies." (MP)

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Classroom Implementation Study of An Activities-Based Supplemental Mathematics Program

Final Report to the
National Institute of Education
United States Department of Education

Helen Slaughter, Principal Investigator
Department of Legal and Research Services
Tucson Unified School District
Tucson, Arizona 85719

Lisa Leiden, Barbara Markert, Peggy Placier
and Judy Walters Ethnographic Assistants

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CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED SUPPLEMENTAL MATHEMATICS PROGRAM

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This research described the classroom implementation of a supplemental activities-based mathematics project designed for low-achieving students. The research describes the development of applied ethnographic methods for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. A model for use by school district evaluators in conducting ethnographic evaluation studies was developed.

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Protocols of each observation, including those of the mathematics inservices, served as the basis for case studies produced for each of the eight sites.

Themes emerging from the study indicated that the predominance of classroom structure, the conditional nature of classroom teacher-resource teacher collaboration, teacher inservice, and teacher's evaluations of subsequent student achievement growth were key factors in program implementation.

Ethnographic descriptions of mathematic classroom activity structures provided a number of insights into the contribution of mathematic games and other manipulative aids to the learning of low-achieving students.

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CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED SUPPLEMENTAL MATHEMATICS PROGRAM

Executive Summary

This research describes an in-depth classroom implementation study of a supplemental activities-based mathematics project designed for low-achieving minority students. The research supplemented existing evaluation procedures to allow for the development of applied ethnographic methods in program evaluation. The focus of the study was the development of procedures for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. The study also addressed questions arising in practice and in the research literature about the mathematics learning of low achievers in an instructional program using manipulative aids.

The research consisted of ethnographic observations of mathematics lessons and student learning in nine classrooms in eight schools serving low-income attendance areas. Observations (10-15) were conducted over approximately a five-week period by three trained ethnographic assistants. Classrooms observed were Grades 4/5, 2/3, 2/3 and 2 (fall), Grades 5, 4/5 and 3 (winter) and Grades 3 and 5 (early spring). A brief followup study occurred in spring in one Grade 2/3 classroom. Observations were scheduled before, during and following the delivery of classroom services of Mathematics Project Specialists.

An ethnographic methodology was used in an attempt to generate hypotheses, and accommodate the research to natural classroom and program implementation processes. While a number of research questions served to focus observations, an attempt was made to produce protocols that were richly descriptive of the classroom structure and interactional processes as they happen.

Protocols of each observation, including those of the mathematics inservices, served as the basis for case studies produced for each of the eight sites. Both the protocols and case studies were reviewed by teacher collaborators during a two-day research colloquium. The case studies presented a variety of classroom mathematics activity structures occurring over a period of a four- or five-week time span and illustrated the use of manipulative aids and games and student responses to them, in a variety of contexts. Data presented in the case studies suggested that the successful participation of low-achieving students in the instructional process is increased by a multigroup, multitask structure when teaching with manipulative aids.

A number of themes emerged from the study regarding program implementation. Major themes include the following:

1. The ambiguity of the resource teacher role resulted in a wide variance in the scope, structure and quantity of services to different classrooms. Offsetting this were carefully planned, well-articulated half- and whole-day mathematics inservices. Teachers felt the inservices were an essential element in enabling them to implement the program.

2. There were a number of conditions to classroom teacher, resource teacher collaboration. These included teacher control of the classroom, group management, content to be taught, amount of time to be spent in the classroom and sharing or nonsharing of methods and materials.

3. Preexisting classroom structure before entry of the resource teacher, and/or concern for total class management had a determinant affect upon how the resource teacher fit into the classroom.

4. The prototypic model for classroom teacher/resource teacher collaboration appeared to be that of a team teaching rather than a demonstration model. Although some other styles of direct services of resource teachers were observed, the team-teaching model seems to depict the most acceptable (to both classroom teacher and resource teacher) participant structure for the implementation of the resource teacher service delivery strategy.

5. Some teachers evaluated the effectiveness of an activities approach to mathematics, and of the resource teacher services with tests administered shortly after the delivery of resource teacher services. Student success or failure on the tests, despite some mismatch between the curriculum focus and test items was seen to be reflective of the effectiveness of the program. This was indicative of the need for appropriate and specially designed evaluative end-of-unit tests to be used by teachers in evaluating student learning.

6. Program "treatment" was found to be nonuniform. There were a wide variety of local school and classroom contexts and extenuating circumstances influencing implementation including, (a) wide variation in time allocated for mathematics, (b) stability/change of principal and faculty of school staffs, (c) extra adult assistance in the classroom for program implementation varied from none to three, (d) a wide range of direct resource services given to any one classroom from 4-14, and (e) there appeared to be a wide variance in curriculum scope, e.g., number of concepts, terms and complexity of mathematics skills, covered on a topic among classrooms.

7. The mathematics program was partially defined as it was being implemented. One value of direct services of resource teachers

has been to enable them to modify, refine and further develop the program as a result of their experience in the classroom.

The study provided a number of insights into the contribution of manipulatives and games to the mathematics learning of low-achieving students. The observational data suggested that manipulative aids such as Cuisenaire rods and pattern blocks were very appropriate for the instruction/learning of the low-achieving student. Often low achievers were more successful doing manipulative activities than other math activities. However, in using manipulatives for instruction, students must first be taught the meaning and use of the technology of manipulatives. The data provided numerous examples of teaching children the meaning of, and even how to construct, manipulative aids. Much guidance to individual students was observed in the use of this instructional strategy, and because of this, small-group instruction seemed more appropriate, especially for low-achieving students, than whole-group instruction.

The skillful use of manipulatives in instruction required a high degree of teacher/aide training. This was provided in the inservices, as a first step, (sometimes followed by demonstrations) and facilitated through the use of worksheets that could be used within the guided instructional process to help teachers structure the lesson. Some of the worksheets as well as other activities were invented by the resource teachers to help classroom teachers 'think like mathematicians' in the instructional process. Also worksheets were used to help students make the transition from the manipulative level to the symbolic level.

In most classrooms students were observed playing mathematical games. However the role games played in instruction varied, as did student response to the games. Teachers seemed to view games as either a teaching strategy, i.e., games were used as a part of instruction and learning new concepts and facts, or for use as maintenance of skills already learned. Sometimes games were used as an independent small-group activity but this was difficult to manage without the supervision of an aide or other adult in primary grades. Also groups of younger students, Grades 2-3, appeared to have difficulty in managing the competitive aspect of the games without supervision. Training in gamemanship appeared helpful and was sometimes provided by the resource teachers. Game playing of self-selected partners was more easily managed on an informal than an assigned group activity basis when adult supervision was unavailable.

Games appeared to be a potentially useful way to diagnosis individual skill attainment and give individual assistance in skill and concept development to small groups of students. When observing games used as a teaching strategy, it was clear that individual low-achieving students benefited from adult help.

This study describes an applied ethnographic model that can be adopted by school district evaluators to study program implementation within classrooms. The model describes (1) setting the context with program implementators, building principals, teachers and students for conducting an observational study, (2) ethics of ethnographic research, (3) training classroom ethnographers, (4) developing procedures for data collection and reduction, (5) analyzing the results and (6) reporting the results.

This research was divided into three sections; Part One: An Ethnographic Evaluation of Program Implementation, Part Two: Mathematics Learning of Low Achieving Students Through Mathematics Games and Other Manipulative Aids, and Part Three: Eight Disaggregated Case Studies.

Addendum to Final Report to the
National Institute of Education
United States Department of Education

The following reports were prepared for NIE:

1. Abstract
2. Executive Summary
3. Final Report:
   Part One: An Ethnographic Evaluation of Program Implementation
   Part Two: Mathematics Learning of Low Achieving Students Through Mathematics Games and Other Manipulative Aids
   Part Three: Eight Disaggregated Case Studies

During the project year the following dissemination activities for this project occurred.

1. Paper presented at the Annual Meeting of the American Educational Research Association, Los Angeles, California, April 15, 1981, Classroom Ethnographic Study of An Activities-Based Supplemental Mathematics Program.

2. Two-day Colloquium for Teacher Collaborators participating in the project. This collquium afforded teachers the opportunity to read and review the protocols and case studies based upon observations of their classrooms. Two mathematics specialists and three ethnographic assistants also participated in the collquium. Teacher response to the data indicated high interest and approval. Teachers also made suggestions regarding program improvement and development.

   Consultant, Dr. David Berliner, made a presentation placing this research study within a historical perspective of classroom research. Consultant, Dr. John Chilcott, related some of the findings as presented in the case studies to anthropological concepts.

   An advisory committee meeting to discuss results of the project was a part of the colloquium and was attended by Dr. Mary Belle McCorkle, Assistant Superintendent of Instruction and Mrs. Barbara Benton, ESEA Title I, Assistant Director, Elementary Projects.

3. Dissemination List for Part I and II of the final report.

   A. Tucson Unified School District

      Ed Arriaga, Director, Instructional Support, State/Federal Programs, K-12

      Mary Belle McCorkle, Assistant Superintendent of Instruction

Felizardo Valencia, Director, Legal and Research Services

Stan Paz, Director, Biligual Education

Barbara Benton, Assistant Director, Title I Elementary Projects

B. Others

Gene Benton, Assistant Superintendent, Region III

Cheryl Helmick, Title I Research Evaluator

Carol Brooks, ESEA Title I Mathematics Project Specialist

Sandy Keintz, ESEA Title I Mathematics Project Specialist

Judy Bolt, ESEA Title I Mathematics Project Specialist

Angie Ortiz, Coordinating Project Assistant, Lau Project

C. Consultants

Dr. David Berliner

Dr. John Chilcott

Dr. Carol Larson

D. Other Researchers

Dr. Barbara Prentice

Dr. Robert S. Strom

E. ESEA Title I

Mr. Donald Kearns

4. Future Dissemination

Several journal articles for future dissemination are planned.

For example:

Elementary School Journal;

Special issue on student responses to instruction. Possible title: Insights from an Ethnographic Study of Student Learning Through Mathematics Games and Manipulative Aids

The Journal of Mathematical Behavior and/or Arithmetic Teacher (with Carol Larson, consultant) possible title: Mathematical Games and the Sequence of Instruction; The Tale of Two Case Studies

American Educational Research Journal possible title: Applications of Ethnography to Studying Implementation

Paper proposal, American Educational Research Association, Annual Meeting, NYC, 1982, title: Mathematics Learning of Low Achieving Students Through Mathematics Games and Other Manipulative Aids

5, Teacher Training

The ethnographic materials may be useful for training teachers (this view point was supported by consultants, Dr. David Berliner and Dr. Carol Larson).

I plan to meet in the fall with the Title I Mathematics Project Specialists and Dr. Carol Larson to discuss the implications of the case study data for teacher training.

Also, a copy of the report will be given to Joyce House, Project Director of the 'Equals' Project: Sex Equity in Mathematics Education for TUSD. This project was funded under the Office of Civil Rights, Title IV, subpart E school board grant, July 1, 1981 through June 30, 1982, $53,165. The project is a teacher inservice project for training 40, Grades 4-8 teachers, in ways to improve mathematics competence and confidence; some of the inservices will focus upon using activities to improve confidence or reduce anxiety which is related to this research.

6. Requests for Final Report

Herbert Ginsburg, Professor and Chairman
Graduate School of Education and Human
  Development
University of Rochester
Rochester, NY 14627

Classroom Implementation Study of An Activities-Based Supplemental Mathematics Program

PART ONE:

AN ETHNOGRAPHIC EVALUATION OF PROGRAM IMPLEMENTATION

Final Report to the
National Institute of Education
United States Department of Education

Helen Slaughter, Principal Investigator
Department of Legal and Research Services
Tucson Unified School District
Tucson, Arizona 85719

Lisa Leiden, Barbara Markert, Peggy Placier
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NIE Teaching and Learning Grant G-80-0090
August 1, 1980 through July 31, 1981

SE 037 088

ACKNOWLEDGMENTS

The NIE Mathematics Project, as this research came to be known, involved principals, teachers, aides and children in eight research site ESEA Title I schools and three other schools used for purposes of training observers. So many persons were involved that it is an impossible task to thank all. Our greatest debt, of course, is to the classroom teachers and mathematics resource teachers who collaborated in the research, and to the students whom we observed.

Special appreciation is given to the members of the advisory committee for the project who facilitated implementing the research, Dr. Marybelle McCorkle, Assistant Superintendent for Instruction, Dr. Stan Paz, then Assistant Director for Federal Programs, Felizardo Valencia, Director of Legal and Research Services and Barbara Benton, Assistant Director for ESEA Title I Elementary Schools Projects.

Appreciation also is given to Dr. Barbara Prentice, former Director of the Research and Evaluation Department, for her encouragement in the preparation of the proposal for this project. We are deeply grateful to the staff and principal, Charles Tyree, of Smith Elementary School who served several times as a site for training the Ethnographic Assistants for the project.

A very special recognition is due to Dr. David Berliner whose ideas were fundamental to the research design, and to him and Dr. John Chilcott for helping to develop and present a training program for the ethnographers, and assisting with the research throughout the project. Appreciation also to Dr. Carol Larson for reviewing the final research report.

Special appreciation is also given to Cheryl Hromidko and Shelby Erwin for their patience and care in providing secretarial services for the project.

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PART ONE

Classroom Implementation Study of An Activities-Based Supplemental Mathematics Program

Recently there has been a trend away from exclusive reliance on traditional social science models in educational evaluation because they apply to only a small proportion of questions and are rarely practicable in the natural environment of the public schools (Scriven, 1978; Cronbach, 1978; Guba, 1978; Stake, 1978; House, 1977). Guba (1978, pp. 79-80) in writing about a practitioner movement towards naturalistic inquiry in educational evaluation, has stated a need ". . .to enlarge the arsenal of investigative strategies available for dealing with emergent questions of interest; to provide an acceptable basis for studying process, to provide an alternative where it is impossible to meet the technical assumptions of the experimental approach in the real world,. . ." Further, naturalistic or qualitative approaches have been seen as a way to meet the growing demands for evaluations that can be utilized in generating recommendations for improving program effectiveness (Alkin, Daillak, White, 1979; Patton, 1978). This present study was an outgrowth of the limitations of the control group model of the current Title I Evaluation and Reporting System to provide sufficient information for decision-making (Slaughter, 1980).

Naturalistic inquiry is defined by an approach used when the researcher designed the study to fit the situation and answer social policy issues that often cannot be examined by altering the situation. Ethnography is a type of naturalistic inquiry where a trained observer attempts to describe a social situation as it functions naturally. As stated by Fienberg (1977, p. 52), "Rather than assess the effectiveness of teaching by traditional techniques of test scores administered before and after some 'treatment,' the ethnographer chooses to investigate how events within the classroom and the interactions between teachers and students affect the learning process. This view of the basic inquiry has led ethnographers to the method of direct observation (most typically nonparticipant observation) for data collection." Ethnographic methodology, using trained observers of holistic behaviors of students, teachers and others (and patterns of relationships among them) in school settings has seemed especially relevant to understanding educational practice. Tikunoff and others (1975) developed procedures for integrating shorter term ethnographical observations with other types of data to increase our understanding of classroom instruction and student learning. Johnson and Gardner (1979), suggested some first steps in developing a prototypic model for training ethnographic assistants to work with research staff to fulfill fieldwork commitments in conducting a classroom ethnography of reading instruction.

The objective of this study was to conduct an in-depth classroom implementation study, using ethnographic methods, of a supplemental Title I mathematics project. The focus of the study was the development of procedures for observing and describing the way programs are implemented using curriculum specialists or resource teachers to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. The ethnographic approach used also addressed questions arising in practice and in the research literature about the mathematics learning of low achievers in an instructional program using manipulative aids, that are related to the improvement of compensatory education programs.

The Evaluation of Resource Teacher Programs: Related Literature and Research Questions

Programs employing resource teachers in specialized areas have been one way that administrators have attempted to improve classroom curricula and meet the special needs of individual students. This is one way that scarce resources can be extended to benefit a larger number of students than would be possible through provision of teachers giving direct services to children on a daily basis. Resource teachers' assistance within the classroom is a "mainstream" approach to compensatory education and may have advantages over pullout programs (Glass and Smith, 1977). One such advantage may be articulation of the resource teacher's program and the ongoing classroom program. Empirical research was needed to affirm or disconfirm this speculation.

Unfortunately, the complex organization required for resource persons to effectively assist teachers in improving the instruction of low-achieving students in more than a superficial way remains a problem. For instance, Milofsky (1974, p. 439) described the problems of managing school politics in supplemental programs and the chronic problems of resource teachers in gaining access to regular school personnel and priorities. Harry F. Wolcott, (1977, p. 243) in a study which focused on the social organization of an educational innovation stated, "Too many researchers have. . .been too attentive to innovations and too inattentive to how educators organize to cope with them." The need for research that takes into consideration the process of mutual adaptation of the implementors of an educational innovation and the users, e.g. teachers and students, was pointed out by Fullan and Pomfret (1977).

There has been a need for observational research studies on the actual implementation of the resource teacher service delivery strategy in practice in naturalistic settings from a user perspective. An observational study is particulary appropriate since the introduction of resource teachers into the regular classroom implies role changes for classroom teachers, students, and resource teachers. Fullan and Pomfret (1977) indicated that a main problem of implementing new curricula is that curriculum change often means that new role relationships are required of persons putting the innovation into practice. Research on the use of manipulative aids in teaching mathematics has shown that the teachers effect is overwhelming (Suydam and Higgins, 1977).

There is no way an apriori system of observational categories would validly reflect the interaction of classroom teacher, Mathematics Specialist and students for understanding the implementation of this type of program. Even tightly controlled studies of teacher effectiveness have found preset categories in observational instruments were not always appropriate for an evaluation of an intervention (Stayrook and Crawford, 1978).

Naturalistic observation was especially appropriate to the fluid situation of nonresearch-based compensatory education projects. However, observation is always selective (Spradley and McCurdy, 1972) and must necessarily be focused in ethnography used for evaluative purposes. According to Erickson (1977, p. 62), "Focused data collection. . .required knowing something about the setting one is studying through information gathered before entering the setting as well as from first hand experience." The apriori research questions guiding focused observations during the study are listed below. This list is illustrative only, not exhaustive, since many more research questions arose, as expected, during the study. One of the purposes of qualitative research is to generate hypotheses. Examples of questions used in focusing observations were as follows:

1. How do the resource teachers, i.e., the Mathematics Project Specialists, establish rapport with classroom teachers and children?

2. What are the opprotunities and for how long are classroom teachers able to observe the demonstration lessons in the regular classroom context?

3. Does the classroom teacher make some special arrangements to provide space, time, different groupings of students, and activities for nontarget students during scheduled demonstration lessons?

4. How does the focus and content of demonstration lessons vary with type of classroom, composition of target group, cooperation of classroom teacher, etc., from one site to another?

5. What is the percentage of mathematic manipulative activities to other kinds of mathematics instruction in the classroom? Does this change after the demonstration lessons?

6. Are the demonstration lessons coordinated with the regular mathematics program received by the target children?

7. What kind and what degree of guidance is given to students during the manipulative phase by Mathematics Project Specialists and by classroom teachers?

8. Is there evidence of transfer of concrete manipulations to symbolic records during the observation period?

Design of the Study

This study reports some emergent findings from a series of eight disaggregated single case studies of the implementation of a supplemental mathematics project with the classroom serving as a unit. Kennedy (1979) related the importance of the single case study approach for documenting the effects of treatment and also the reasons for these effects. Carrying on the study at multiple sites shows how the treatment functioned for different recipients, both students and teachers, in different contexts. According to Kennedy (1979) generalized statements regarding program effects are of limited validity because of the wide variation in treatments, intervening influences and extenuating circumstances in implementation. Attempts to clearly define any single program treatment and its affect upon achievement is further confounded when students participate in several programs including the specific program ongoing in the regular classroom. Statements of program effects in terms of gains scores aggregating student pre-posttest means across classrooms and schools are only meaningful to the extent that program implementation is uniform.

This study, while primarily ethnographic in approach, was conceived as analogous to an ABA time series design in psychology, as described by Kratochwill (1978, pp. 41-42), in that it incorporated measurement of baseline conditions, measurement during the intervention phase and measurement after the intervention was withdrawn. However the context of this study was very different from the typical experimental study in that the "intervention" itself was in need of verification. While it was assumed that during the intervention process the dependent variables would be improved, i.e., student involvement and success on mathematics tasks, the point of the study was to see if there was improvement immediately after the treatment and to determine the length of time of treatment effect. Further, if the treatment successfully improved the mathematics performance of the target students, there would not be a return baseline condition. According to

Kratochwill (1978, p. 42), "This mitigates against the logic of the design and would not allow investigators to establish experimental control." In a naturalistic inquiry of this sort, experimental control is neither attempted nor is it necessary. The ethnographic approach was highly appropriate since it could be used to provide information about a program that, since implementation did not follow a preset plan, could not have been evaluated using an experimental model.

Classroom Observation and Data Collection

This section contrasts the preplanned and actual research agenda for conducting and writing up ethnographic observations. This is done to assist others in planning ethnographic evaluations.

Planned Research Agenda. During the first series of demonstrations in the fall of 1980, three ethnographic assistants will observe three different classrooms for a period of one month. The principal investigator will observe at least four times in each classroom participating in the study. Narrative records of the observations will be typed daily. The typed records will use code names for participants observed.

The observation plan is as follows:

1. An ethnographic assistant knowledgeable about the mathematics curriculum will observe the mathematics target students for one week prior to the demonstration lessons. The observer will know who the target students are and will make narrative records on what happens to them during the mathematics period. This will include records on what the teacher is doing.

2. The observer will watch the mathematics demonstration lessons of the systematic use of one or more manipulative aids and make narrative records of the teaching strategy used, the target students' responses, indications of the regular teacher's observations of the lesson and any other pertinent factors, such as what the remainder of the class is doing at this time.

3. The observer will be in the classroom for the next ten school days following the demonstration lessons. Records will be kept of the activities of the teachers and target students during the mathematics class and the students' responses to it.

4. Once a week, or more if necessary, the ethnographic aides will meet with the principal investigator to discuss the observations and any problems in carrying out the study.

The above plan will be repeated for a second round of demonstration lessons in three different classrooms later in the year. Later, two more classrooms will be observed. Consultation with teachers, Mathematic Project Specialists and district curriculum administrators will supplement and enlarge the scope of the study.

After the initial series of observations are completed, the data will be compiled into a preliminary report. At this time, procedures for simplifying the observation--data collection process--will be explored. For instance, a format for reporting data back to the principal investigator after observations, will be developed if possible. Then more highly focused observations will be used for conducting observations in three more classrooms at midyear and to more classrooms later in the spring. One observer will return to the first classroom observed to provide a longer view of the treatment effect on students.

Actual Research Agenda. Three ethnographic assistants were trained in late September and October and scheduled observations over a month's time in three target classrooms and in one other classroom where the teacher was team teaching with the teacher in a target classroom. As seen in Table 1 (Appendix A) fewer observations by either the principal investigator or the ethnographic assistants occurred than originally planned. Observations were planned for a maximum of four days a week to allow the teacher breathing space of one day without observers and school activities such as Halloween Parties, teacher absences, etc., further reduced the observations. We felt that the number of observations made were sufficiently representative of classroom activities during the observation period. Principal investigator observations were reduced due to the time required in the human relations context of establishing the study in the schools and coordinating the research with actual instances of program implementation. It should be noted that after this was accomplished, in the fall, scheduling later observations in the remaining five research sites was much smoother. Principal investigator (PI) observations served the purpose of (1) maintaining contact with people in the field, (2) providing opportunities for developing shared perspective and dialogue between the PI and ethnographic assistants, and, most importantly, (3) providing direct experiences within each research site to the PI which proved indispensible in developing theories about implementation and for further focusing observations. One method of focusing the ethnographic assistants observations was for the principal investigator to provide example protocols developed from observations in the research site classrooms.

Narrative reports, also called protocols, were not typed daily. We found that each hour of observation required a minimum of three hours writeup time. While ideally each observation should be written up before succeeding observations, this was not always possible. A form was developed (see Appendix B) for handwritten protocols.

While initially we had planned one week of observations before the intervention and two following it, we found it preferable to spend two weeks in the classroom before the intervention occurred. This was necessary to ensure the correct identification of students and familiarity with the classroom routine. Learning students names and correctly identifying target students was more difficult than we had expected. This was probably due to the nonparticipant nature of the observations. However, as the study progressed descriptive data on individual students over several days time improved.

Primary observations were focused upon the classroom setting as a sociocultural unit, not individual target students. Gump (1980), from the perspective of ecological psychology, suggested that one needs to observe the setting unit first and stated, "One has to assume a different observational stance for settings." Observations of settings are more difficult to focus because of the wide choice to co-occuring events or episodes, especially in multi-task, small group, organized classrooms. However, since classroom episodes last longer, e.g. 20 to 30 minutes, or more, than individual behavior patterns, observers can often collect data on both settings and individual behavior (Gump 1980; 1974). It was especially important to observe settings over time and to extend observations through collaboration with classroom teachers.

According to Gump (1980, p. 14), information about settings is indispensible in studying implementation:

> A description of a setting, independent of subjects' behavior is required. The systematic observation and the quantitative description of settings, as opposed to individual behavior, would seem to be a useful, even necessary skill. . . Many of the interventions to be evaluated involve settings: Classrooms, office, staff-development workshops, teachers meetings, playgrounds and so on. Problems to be solved often appear in such settings; interventions are often applied in such settings, impacts of such interventions need to be examined in such settings. For some problems, the impact of intervention creates setting changes which then change individual behavior and experience. In fact, without a sturdy and comprehensive setting change, many interventions will be impotent.

Our perspective throughout the data collection phase of the study has been to pay attention to the classroom unit while moving from group to group, especially those containing target children or being instruction by Title I mathematics resource specialists, to collect data on interaction among persons and responses of individual students. Methodological suggestions regarding improving the focus of observations and of protocols are found in a later section. We found that the dynamics of the interface between classroom teacher and mathematics resource personnel with negotiation of the specific form and content of the Title I mathematics services taking place during, as well as previous to intervention, obviated the possibility of using any preset or quantitative approach to observation. To have attempted to use a less ethnographic approach would have been to ignore the richness of the data and would not have been practicable.

A training program for the ethnographic assistants was planned and implemented with the assistance of consultants Dr. David Berliner, educational psychologist, and Dr. John Chilcott, educational anthropologist. The mathematics resource teachers were also invited to participate in the training sessions. Topics discussed during training are found in Appendix C. The selection and training of ethnographic assistants is summarized in the model found at the end of this report. The attempt to promote the development of a distinctly "ethnographic" approach to studying classroom implementation and trainee responses to it is described below by Chilcott.

Training of Classroom Ethnographers: An Educational Anthropologist's Perspective

It is no easy task to move a group of people, each with his/her own cultural experience and professional perspective, in a few short days toward an entirely new professional perspective or world view. It has been my experience that it takes anthropology students who are daily immersed in coursework several years to acquire what is commonly referred to as the "anthropological perspective."

Although reading several essays on the topic (Kimball, 1963), (Ianni, 1970) may prove useful to the trainees, it is important to keep in mind that a classroom ethnographer is severely limited in what he/she may accomplish. It became as much a task of the training sessions to make the trainees aware of these limitations so as to reduce their frustrations as to convince them of the value of anthropological research.

One purpose of the training sessions was to move the trainees from the world view of their particular professional or social science training to the world view of anthropology. This in of itself was a cultural change process since these individuals felt secure in and convinced that their training was superior to other social sciences.

It was also a task to provide the rationale for ethnographic research, a type of research methodology which is unique among the social sciences, and the goals of ethnographic method. The nonjudgmental character of the ethnographic method and anthropological insights was particularly difficult to communicate since the ethic of professional education is to make judgements of good and bad pedological methods and since the purpose of the ethnography was to serve as an evaluation of a particular curricular activity.

A series of lectures and reading materials were provided to illustrate the goals of anthropology and the use of ethnographic method in acquiring cultural data. A few examples of ethnographies in nonwestern settings were provided (Geertz, 1973) with particular emphasis upon method and results in order for the trainees to arrive at an understanding of what the term "thick descriptions" connotes.

Both the emic and etic methods were explained and illustrated using examples from the research conducted by this researcher (Chilcott) in educational settings. A discussion of the use of informants to gather additional information about observed events in the classroom followed. A practice session involving observation and the use of informants was provided through attending an inservice training session for teachers. These observations and information from informants were compared and analyzed in terms of what information was being missed and causes for the differential data among the trainees.

Other practice sessions included a taped TV sequence of a third grade classroom in which the trainees again wrote out their description, compared them, and discussed what cultural data they had not seen and what cultural data was missing from the TV sequence. At this time the concept and procedures for event analysis, and the sequencing of events was introduced. It also became apparent during the exercise of the limitations of using TV data in classroom ethnography and of the need of the observer to utilize the holistic approach in understanding the cultural determinants of the sequencing process.

A sample of protocols used in previously conducted classroom ethnographies were reviewed noting their advantages and disadvantages. In order to overcome their deficiencies, the trainees were encouraged to use classroom protocols solely as a mnemonic device for later analysis and the writing of "thick" descriptions of the classroom observation. It was estimated that the classroom observers in order to become classroom ethnographers would be required to spend three to four hours of post observation analysis in order to complete the ethnographic description of a one hour observation.

It was at this point that the trainees frustration level reached its apex. They became simply overwhelmed at the task both as to its time frame and their ability to cope with a large amount of cultural data. It was necessary to reassure them that with additional experience in the day to day reality of classroom ethnography, their skills in data collection and analysis would improve immeasurably and their task would not be as overwhelming. A comparison with a corresponding time sequence of an ethnographer in the field who could easily be overwhelmed with the language, data, and strangeness of a foreign culture during the first few weeks in a village or camp, was useful at this time.

The nonjudgmental feature of ethnographic research required constant reinforcement during the entire period of training. The trainees were constantly being reminded through specific illustrations drawn from their observations of the "cultural baggage" which they were carrying which was biasing their observations. This was particularly apparent in their making judgements as to what constituted good and bad teaching. The acquired skill in making objective observations required a longer period of resocialization than had been anticipated by the trainees. Again a comparison with cross cultural ethnographic descriptions was a useful device in acquiring an objective viewpoint.

There was also a discussion of innovation and cultural change process both in terms of innovation in education and of cultural change within educational institutions with particular reference to both the new curriculum which they were observing and to ethnographic research as innovative in educational research.

It became obvious after a few training sessions, that it would be necessary to constantly reinforce the early training throughout the entire classroom ethnographic observations in order to make constant revisions of the approach and to improve the ethnographic skills of the observers. Similar to novice anthropological field workers, the best and richest ethnographic descriptions would appear near the conclusion of the study. Alternatives in the style and form of writing protocols developed over the course of the study described below was one attempt to improve the quality of the data.

Writing Protocols: Alternatives in Style and Form for Classroom Ethnography

As noted, in the initial training of the ethnographers, examples of protocols from previous classroom observational studies were used as models. The sources of the models were Cassell (1978), Evertson (1980) and Tikunoff, Berliner and Rist (BTES, 1975). While the models were useful in the development of a methodology for producing protocols to serve as a first draft of an observation, there were several problems associated with their use in this form for school district evaluative research. Admittedly, the detailed record of ongoing events was essential to the study, but the exclusive attention to detail resulted in protocols that were laborious to write and not easy to read. To be perfectly candid, they were boring and required an enormous effort on the principal investigator's part in using them as a basis for analysis. Therefore, we began reexamining the protocols to find ways of improving their readability within the parameters of our research goals of (1) producing documents that would contain rich descriptions of classroom life, (2) maintaining an impartial, nonjudgmental stance, (3) providing data which would be a source of our interpretations regarding factors related to program implementation (the learning of low-achieving students, etc.) and (4) providing a database that could be used by the principal investigator within the relatively short timeframe of evaluative research and the one-year NIE grant.

In modifying the protocols we looked at two somewhat interrelated aspects of a protocol. There were (1) format, style and the ethnographer's presentation of self within the protocol and (2) a need for a nomenclature for conceptualizing and describing phenomenon observed in the classroom.

Format, Style and the Ethnographer's Presentation of Self

Research is generally written in the past tense and mention of the researcher, if at all, is in the third person. Scollon and Scollon (to appear, 1987) would term this as the Western essayist style which is highly decontextualized, and "the author as person by a process of writing and editing seeks to achieve a state of self-effacement." The standard research report is an example of essayist literacy as defined by Scollon and Scollon (in press):

> The ideal text is closed to alternative interpretation. It is nonindexical. Nothing outside the text is needed for interpretation. These factors have important implications for the discourse structure. The important relationships to be signaled are those between sentence and sentence, not those between speakers nor those between sentence and speaker. As reader this requires a constant monitoring of grammatical and lexical information. In spoken discourse the listener can get a good bit of the meaning from the context. In reading essayist prose the clues to interpretation are in the text itself.

Students of the social sciences are taught to use the past tense, impersonal nouns and the third person for self-referral as a way of "distancing" themselves from the research. Educational researchers and evaluators, as well as other social scientists, are accustomed to reading research written in this style. Ethnography also is usually published in this form. However, neither the protocols used as models nor the ones we were producing during the first stage of the research study were in this form. The protocols read like eyewitness accounts of processes as they were happening with the ethnographer appearing in the first person, as a quasi participant. Even though the protocols were sometimes called narratives, they weren't very good narratives according to essayist literacy or "research" standards. This may have been one reason that they were difficult to read. Looking backwards, the protocols in the Tikunoff, Berliner and Rist (1975) study were produced at first by the ethnographer tape recording from his notes and memory of the observational material. This was later transcribed by a secretary into a typed continuous numbered line format. Therefore, the method of recording may have produced the narrative style of these protocols. In our study, funded under the NIE small grants program, protocols were written out (from notes and memory) by the ethnographers directly on lined paper similar to those used in previous studies. Initially this was done instead of tape recording to save time and money. However, because our protocols are written not audiotaped, the ethnographer has an opportunity to make stylistic decisions as a writer regarding the form the narrative will take. In other words, the BTES protocols were much more a first draft than written protocols necessarily have to be. The process of writing itself incorporates a kind of editing that may not be as apparent or the same in audiotaping. These writeups took approximately three hours of writing time for each hour of observation. At issue, of course, is the desirability of changes in form and the philosophical, political and theoretical assumptions and implications of these choices.

One of the goals in refining the protocols was to create research documents that can more readily be used in evaluation. This necessitates having the ethnographic assistants produce documents that are easily used by some other reader within definite time constraints, both for the producer and the user. Furthermore, it might be desirable for the protocols to be directly used as case documents with teachers and/or administrators in certain instances without the requirement of rewriting. For instance, a relatively simple format change from the numbered linear style to one using topic headings and indented paragraphs would improve readability.

A more important change would be to use the form of a transcript such as found in sociolinguistic research for recording segments of interactive discourse as follows (Protocol 1/28/81, Study E, PI, pages 5, 6):

> After speaking briefly with an adult female who came into the room, the teachers came over to the corner group and holding up the orange (10) rod asked Bill, "What's another name for this?" Although trying to answer, Bill couldn't respond with the correct answer. Then the teacher started questioning Penny using the following:
>
> T: What is this? (White rod, 1)
> P: One
> T: What is orange?
> P: Ten
> T: What is red?
> P: Two
> T: How many reads equal orange?
> P: Five
> T: Then what is another name for orange?
> P: Five-fifths
> T: Okay

Mehan's research (1980) done with videotaping provided a rich description of classroom interaction that can be applied in a modified way to more traditional approaches to classroom ethnography such as found in this study. When observations include this type of data about interactive discourse, including peer group discourse, the transcript provides a quick and easy reading of the dialogue.

The protocols could also be improved if they were generally written in the past tense, with only occasional instances of other tenses such as the present tense, where it was particularly appropriate. This has been a recommendation to the EAs although the tendency still remains to present the data as an unanalytical, eyewitness account. Written narratives found in literature or other descriptive writing, including ethnographies, are generally in the past tense and therefore there are reader expectations that research protocols would also be presented in the past tense.

The ethnographer's presentation of self is a much more complex and potentially controversial issue since the method used may convey subtle implications about the role of the researcher in conducting the research.

In selecting a style (and possibly an epistemology) for his or her presentation of self, ethnographic observers can choose to:

1. Write about her/himself in the third person, e.g. the principal investigator, the observer. . .

2. Write essayist prose where the observer is not referred to at all in the narrative and events are stated in typical research style of the past tense, e.g. "observations focused upon the aide's group. . ."

3. Use the inferred first person of eyewitness reporting, e.g., "Arrived to find all children sitting quietly on the rug. Ms. T stops talking to children as she raises her hand to address me."

4. Write in the first person. e.g., "I asked Mrs. Franklin to point out Margaret to me--the only target child I had failed to identify. I had probably overlooked her because. . ."

In developing a model for conducting ethnographic evaluation research in the public schools we had made a concerted effort to include teachers as collaborators in the research, adopting a philosophy of researcher-teacher partnership similar to Bawden, Florio and Wanous (1980). While striving to "fit" into the classroom scene as unobstrusively as possible and with minimal disruption to the ordinary flow of events, we were under no illusion about the change in the scene that our presence could produce. Some mention of self then in the protocols would serve to illuminate the kind of relationship established between researcher and classroom actors and would increase the validity of the data for future use. Further, some use of the first person "I" in the protocols would tend to be more "true" to the assumptions and guiding principals of the ethnographic method rather than copying the style of nonnaturalistic methods which tend to separate the researcher from the researched.

This is not to say that the "I" cannot sometimes be overused or inappropriate. We had directed the EAs to refrain from making value judgements but to record their impressions, concerns or opinions in an addendum to the report. We found that while they usually avoided the former, they seldom included the latter. In the second stage of the study, we made a concerted effort to include more analytical or speculative material at the end of each protocol. The issue here is training people to see and describe patterns of events and behavior. In addition, further modification in the method of constructing protocols discussed below may increase their usefulness for evaluative research.

Developing a Nomenclature for Describing Classroom Process

This section of the report will discuss a nascent nomenclature that could be used to describe processes observed in classrooms which are implementing activities-based programs for developing mathematics concepts. This nomenclature may be useful for focusing observations as well as in organizing the data for later analysis. Since this nomenclature will necessarily be a result of our experiences as observers in the classroom and can be considered one of the end products of the study, it will only be discussed in an abbreviated form in this present report.

Some of our "naming" refers to interactional variables while others refer to variables within the mathematics curriculum. Two important interactional variables defined by Philips (1980) are "The Attention Structure of face-to-face interaction, or the behavior of teacher and students that signals who is paying attention to whom. . ." and "Discourse Structure, or the way in which different individuals build on the utterances of other. . ." This is important to our study of the role relationships between classroom teacher and resource teacher in implementation. For example, in some of our research classrooms we have observed a parallel team-teaching arrangement where both teachers have carried out simultaneous teaching activities with small groups of students during the mathematics period with no noticeable paying of attention to the others' lesson. We are also interested in noticing the distribution of talk which occurs (Bateson 1972 and Mead 1977), e.g. which children, high or low-achievers are involved most in whole-group or small-group teacher-directed discourse. Which children continually regain the floor? Another focus for observation is the contrast between child discourse in peer groups with and without adults present. We term this peer group discourse and adult-directed small-group discourse. There appeared to be qualitative differences between the way the Math Project Specialist (MPS), teachers and aides interact verbally with students. Some of our observations suggested that MPS discourse with students and also their modeling in inservices for teachers promoted a more verbal mathematics literacy in students' responses to elicitations. In other words, the MPS will more often ask students to verbalize a "number sentence" or "tell a story," e.g. two times five equals ten, while the responses from children to teachers or aides may commonly require only a one word answer. This type of qualitative difference, if borne out in subsequent observations, would be important to the study of the quality of Title I services received by students and also suggests an area where modification in the Title I program may occur when adopted by nonspecialists.

A major focus of our study during the fall was the observation of children playing math games in the classroom. Mathematics games may be viewed as one kind of classroom activity structure that may occur in classrooms (Berliner, personal communication). Math games were demonstrated and played by teachers during the inservices and were viewed as an important part of the Title I Math Project by both teachers and the Math Project Specialists. One kind of Title I service offered by the MPS was to teach games to small groups of Title I project participants and this was frequently given as the reason for their being in the classroom. The following list includes aspects of classroom game playing that should be included in a description:

1. First turn. When children are in charge of a game without an adult manager, the beginning of conflict or long discussions may be about who goes first, second, etc.

2. Monitoring the mathematical accuracy of moves. How is this done? Can the students monitor each other's moves?

3. Consequences of errors. Can the student practice errors in playing the game? Are there rules and penalties imposed when errors are detected by others?

4. Kinds of errors, accidental or strategic. What kinds of mathematical errors occur? Is there evidence of learning and problem solving during the game? Do some children win because of the errors they are making?

5. Group leadership. Is this an adult dominated group? Is there a struggle for dominance by one player?

6. Learning focus vs. social focus. Is the student's concern mainly with winning the game or is s/he intrinsically interested in the math problems posed by the game?

7. Pacing of game. How long does the game last? Does it hold the attention of all players or just that of the child playing at the moment?

8. Distribution of turns. Does everyone get the same number of turns, winners as well as losers? Can the game be won in one turn?

9. End of game. What happens after the game is finished? Do the children play it again or turn to other activities?

In summary, these are a few examples of aspects of program implementation and observables in the classroom that should be described in the research protocol. Further examples of classroom activity structures observed in this study will be given in Part Two of this report.

Brief Description of the Project Being Evaluated

The Mathematics Pilot Project was in its first year of development in 1978-1979. It was the first Title I Elementary School project in the district to focus exclusively upon mathematics. The goal of the project, that of increasing student understanding of mathematics through effective teaching strategies using manipulatable mathematics materials and a process approach to learning, was built upon the TUSD Mathematics curriculum philosophy. The district had provided a variety of manipulatable mathematics materials to every classroom along with initial inservices during the 1977-78 school year. The Title I effort was directed towards optimizing instructional services for the lowest achievers in mathematics in Grade 3 at eight schools and Grade 5 at nine other schools.

The pilot project was unique in that it was the only Title I project that was experimental in both its conception and its research design, utilizing a service-delivery model that was a compromise between a pullout and a mainstream program. The project design called for three Mathematics Project Specialists (MPSs) to provide mathematics inservices to teachers and to followup the inservice sessions with classroom demonstrations with small groups of target students. Approximately six demonstration lessons were provided to each classroom. This role description was an innovation in that the same people providing a series of inservice training workshops were also showing teachers how to apply the new methods within the regular classroom context. This not only lent credibility to the inservices from the viewpoint of the classroom teachers (who were able to see the teaching strategies in action) but also ensured a greater understanding of the target students learning needs on the part of the resource teachers.

The three mathematics project specialists formed a team with different strengths. One project specialist, a former high school mathematics teacher, had a master's degree in mathematics and had previously worked in the district mathematics staff development and adoption activities. Including a teacher with an extensive background in mathematics was a key factor in the project, since elementary teachers typically do not have a strong mathematics background. Another had been active in the district mathematics adoption process and had been a Title I program assistant. The third was an experienced and successful primary grade teacher. The same people have served in this job role throughout the project.

Mathematics inservices focusing upon the development of mathematics concepts using manipulatives and mathematics educational philosophy were given periodically through the school year. Among other things, this educational philosophy focused upon building insight and understanding of mathematics and avoiding introducing algorithms, formulas, shortcuts and rote learning too early. Manipulatable materials such as cuisenaire rods and the Powers of Ten Kit were used to model both language and notation for developing mathematics relationships and ideas. Strategies were shared which provided increased opportunities for students to experiment, find patterns, and understand their own solution method. The importance of students having systematic experiences with a wide range of problem solving methods, including estimation, trail-and-error, and logical processes, was stressed.

The pilot project, evaluated through the Title I control group model, resulted in no significant differences between treatment and control groups (Slaughter, 1980). One of the weaknesses of that evaluation design was the lack of classroom implementation measures, a lack which this present study proposed to correct. The project name changed to the Mathematics Resource Project in FY80 because the mathematics inservices were extended to all third and fifth grade teachers in the Title I schools in 1979-80, thereby doubling the number of teachers served. Only teachers in schools which had had the pilot project were eligible for receiving demonstration lessons. As the number of inservices had increased, the number of classroom demonstrations decreased to an average of two to the Classroom Demonstration project classrooms. Evaluation of the second year project indicated modest gains for all groups (Slaughter and Helmick, 1979-80). This study occurred during the third year of project implementation.

Research Sample

At the request of the Title I Elementary Schools Coordinator and Mathematics Project Specialists, teachers were not asked to volunteer for the research project until fall 1980. With the exception of one teacher (Study A) who had volunteered for the project during a summer workshop about ethnographic approaches to observing children's language, teachers were not approached until after the Title I Mathematics Project Specialists had met with them individually to determine whether or not the classroom teacher would volunteer for classroom services from them. Twenty-seven teachers out of a possible 73 volunteered for classroom services from the Title I Mathematics Project Specialists. Of these, nine teachers (including a Grade 2 teachers who was team-teaching with a Grade 3 teacher), were asked to participate in the ethnographic study. All agreed to participate as teacher collaborators.

Selection of the classrooms and teacher collaborators was based upon the following conditions being met.

1. Teacher willingness to volunteer for the research project as well as for Title I Mathematics Project Classroom Services. (Mathematics Project Specialists recommended possible teacher volunteers.)

2. The teacher must be at a Title I school and have Title I students eligible for mathematics services in Grades 3 or 5. The classroom must be scheduled to receive Title I services during the observation period.

   Grade 3 students were eligible for Title I services if they were rated as very low in attainment of grade level mathematics concepts and scored in stanines 1-3 on a pretest; Grade 5 students were eligible if they were considered low achievers in math by teachers and had scored below the seventeenth percentile on a systemwide mathematics test.

3. Teacher willingness to provide access for observers (who would be taking notes) to conduct the study.

4. Teacher interest in collaborating with researchers and Title I Mathematics Project Specialists in developing a model for studying program implementation.

5. Classroom characteristics and/or student characteristics unique and of importance, e.g. cultural factors, SES factors, to understanding implementation settings for Title I. For example:

   A. Grade levels included in the study ranged from Grades 2 to 5 as follows: Two Grade 3 classrooms two Grade 5 classrooms, two combination Grade 4/5 classrooms, one combination Grade 2/3 classroom, one team-teaching arrangement with a Grade 2 and 3 teacher working in two rooms.

   B. The classrooms represented different ethnic groups or combinations, and were in different schools.

Initial meetings were held after school between the PI and classroom teacher collaborators during which the research project was explained and teachers gave their informed consent as participants. In eliciting teacher volunteers, the following purposes of the research were given:

1. To develop an alternative/extension to standardized testing for evaluating Title I programs.

2. To deepen our understanding of Title I classrooms and the needs of children participating in Title I

3. To increase understanding of the implementation of Title I programs which use resource teachers in the classroom, in this case mathematics resource teachers.

4. To increase understanding of the broad range of unique classroom contexts in which Title I services are offered.

5. To provide a framework for evaluator/researcher, resource teacher, and classroom teacher collaboration in broadening understanding of Title I programs as they affect classrooms and program participants.

6. To develop a model for studying the implementation of educational programs in the classroom.

Viewing Program Implementation Through the Lens of Applied Ethnography: Some Emergent Themes

There were emergent findings on virtually all of the research questions developed as guides for the study and, in addition, new dimensions and/or conceptualizations of the program and its implementation features became visible as the research progressed. The results reported here are based upon insights gained in conducting the study, protocol data from classroom and inservice observations, and case studies, prepared as separate reports, for each of the eight research sites involved in the study. The case studies, providing an abbreviated and chronological summary of protocol data are referenced by the identifying letter for the site, e.g. A, B, C, D, E, F, G, H. Protocol and case study data, as well as the conclusions presented here were reviewed and discussed with teacher collaborators and resource teachers participating in the study.

These results are organized around a few themes or interpretative trends observed regarding the classroom implementation of the Title I Mathematics Resource Project. As such, program implementation rather than the mathematic content will be the focus of this brief report; Part Two of this report will describe some features of the use of manipulatives and games within the classroom for teaching low achievers. Some major themes:

AMBIGUITY. In talking about the research project with a prospective teacher collaborator the teacher suggested that perhaps teachers need to be inserviced in how to work with resource teachers. That this statement was made by an experienced classroom teacher who had worked in several federally funded schools is suggestive of the ambiguity that surrounds the resource teacher role. In the effort to gain entry into the classroom, and to meet the needs of students and teachers in a variety of contexts, the resource teachers attempted to accommodate their own services to the ongoing situation in the classroom. In doing this there was a tendency for the resource teacher to wait until after individual consultations with the teacher shortly before going into the classroom, or even until after the initial day in the classroom, before fully specifying the kind of services that were to be brought into the classroom.

While the intention of the program implementors to accommodate to individual differences in classrooms was understandable, some unintended outcomes resulted from this ambiguity. First, teachers were often uncertain about what to expect and how to prepare or organize the classroom to best utilize the resource teacher skills. It is hypothesized that one reason some teachers did not choose to participate in the classroom services project was the ambiguity about what their participation might entail. Because there wasn't any shared model or series of models of how teacher and resource teacher should collaborate within the classroom, the actual organizational pattern for their collaboration occurred during the time the resource teacher was in the classroom--a situation that could be highly anxiety producing for all concerned, especially for a resource teacher not wanting to disrupt ordinary classroom procedures. It also could result in a situation where the intended function of the resource teacher's classroom services, e.g. to help the classroom teacher implement an improved instructional program, was undermined. For instance, the resource teacher role could be perceived as similar to that of an aide or of an enrichment teacher, e.g. as someone providing a special "treat" for the students that was not directly related to instruction. This then resulted in a situation that either would be renegotiated further by the resource teacher or, in some cases, the role of the resource teacher remained ambiguous. For instance, in one inner city classroom the mathematics specialist waited until her third day in the classroom before telling the teacher she wanted to work only with students having difficulty with fractions concepts (Case Study I). Only three of the nine teachers (F, G, H) appeared to understand that one purpose of the direct services of the Mathematics Project Specialists was to serve as a demonstration of teaching methods with target students.

IMPORTANCE OF THE INSERVICES. Offsetting the above mentioned ambiguity were carefully planned, well articulated mathematics inservices for which teachers received released time. The inservices provided an essential part of the communicative process in showing teachers how to use manipulative aids in the classroom and also suggesting what topics should be covered at a grade level as well as strategies for grouping. Most in-classroom units used by resource teachers were built around topics covered in the inservices and teachers generally planned to cover those topics when resource teacher assistance became available. In fact, one effect of the classroom services component of the project was to insure the teaching of topics or use of certain methods within the classroom that had been focused upon in the inservices.

Eight of the nine teachers in the study were using an activities approach to mathematics, supplemented by materials and ideas from the inservices, at least for the duration of the study. Teachers stated in the final interview and again during the colloquium following the study, that the inservices were essential in enabling them to implement the program (Case Studies B, C, D, E, F, G and H). They found the time given for learning by doing, especially learning to play the games, and for preparation of materials crucial to later implementation in the classroom. The inservices provided an ideal situation for the mathematics specialists to communicate the specifics of the procedures and goals of the project. It was the one time that the project specialists had the floor. The inservices also served to provide more uniformity to the project since everyone received the same message than would otherwise have been possible.

CONDITIONAL COLLABORATION. One theme of the study concerns the conditions established by classroom teachers and resource teachers in working together in the same classroom. In two of our research sites, classroom teachers were very specific in establishing conditions for their partnership with resource teachers previous to implementing the activities-based mathematics project. In research site H, Mrs. H., the classroom teacher, and the school-site Title I project assistant (who had received training from the MPS) worked together all fall and in January to implement the program. Mrs. H. said that she accepted the offer of assistance from the project assistant on the basis that the project assistant work four days a week in the classroom, that they plan together and that both classroom teacher's and resource teacher's lessons be on the same topic except that the resource teacher would use cuisenaire rods more than the teacher. In research site F, Mrs. Franklin, the classroom teacher, requested that Mrs. Jones, the resource teacher, provide materials and lesson plans that both could use during the week the MPS was in the classroom; during that week the MPS would work on the topic of fractions with the two lowest achieving groups while Mrs. Franklin followed the same lesson plan with the remainder of the class. Further, Mrs. Franklin requested that the fraction unit be restricted to the eights family. In Research Site A, Mrs. A., the classroom teacher suggested that the MPS, Mrs. M., provide activities related to a measurement unit, i.e., area and perimeter, that was being developed in preparation for the classes' outdoor camping field trip. When in the classroom Mrs. A., the teacher rotated all three groups through the MPS activity. Teacher A stated that one reason she had participated in the program was that the Mathematics Project Specialist had said that the program was flexible and would not require her to change her program. (The demands that the classroom unit itself placed on the MPS will be discussed in the next section.) Teachers also tended to change the identification of target students, often adding names to the list, after the resource teacher contacted him or her concerning classroom services.

Resource teachers also imposed limits on their collaboration with classroom teachers. One limitation was the limit placed upon each classroom unit regarding the number and length of time to be spent in the classroom. Others were that the content of services relate directly to a manipulative aid/activities approach to mathematics and that groups worked with would be kept small. A more subtle requirement of resource teacher classroom services relate to the efficiency of the management plan for organizing tasks and social relationships within a specific classroom. Interestingly enough, in two different classrooms we observed the classroom teacher enforcing discipline in the resource teacher group. The resource teacher was perceived as a "guest" in the classroom. It is hypothesized that if these and perhaps other conditions are not met, classroom services of resource teachers will be infrequent.

PREDOMINANCE OF CLASSROOM ORGANIZATION. We found that the resource teachers generally worked within the instructional organization pattern pre-established by the classroom teacher. When children were divided into instructional groups for mathematics, (as recommended by the program) usually the entire class was divided into groups with different activities all related to the same concept. Teachers then asked the resource teacher to instruct one of the rotating groups while they and possibly an aide took charge of the other groups (Cases A, B, C, D, F, H). This structure was followed in the two classrooms where teachers appeared to be having the greatest success implementing the program. In classrooms where the MPS worked only with one or two small groups, the teacher was usually observed conducting whole group instruction with the remaining students rather than observing the resource teachers instruction. (This could be partly an observer effect as perhaps teachers felt they should be "teaching" something when observed.) The small group rotational plan gave classroom teachers the opportunity to guide students use of manipulative and visual aids in learning in an activities approach similar to that of the MPS rather than to engage in recitation organized instruction; attempting the same activity as the resource teacher also provided a shared basis for discussion following the lesson. In any event, it would seem that the organization of the entire classroom group, not only that of one achievement level, must be considered a determinant in how programs will be implemented in the classroom.

The program recommendation that students be placed into small groups for instruction and followup activities also appeared a determinant feature of implementation. Teachers (B, G, H) with consistent, and competent paraprofessional assistance were more easily able to manage the multi-group structure than those who did not have assistance (C, F). Teacher F. was uncertain if she could continue the activities based multi-group approach after the resource teacher had left the classroom without classroom aide assistance. Teacher C. planned to reduce her math groups from three to two in the following year if she did not have classroom aide help. Teacher H. had decided to initiate the activities approach in her classroom after being assured of regular classroom assistance of the school based project assistant in addition to aide and volunteer to manage four math groups. Therefore, classroom management requirements of a change in classroom organization became a factor in determining whether the program would be implemented.

TEAM-TEACHING NOT DEMONSTRATION. The pattern of resource teacher help within the classroom resembled team-teaching more closely than that of specialist demonstrations for practioners within the classroom. Classroom teachers and resource teachers were observed teaching in different parts of the room, seemingly with an unspoken but deliberate effort to not observe the other's teaching. In discussion with another group of resource teachers, they indicated that most of their in-classroom teaching fits a team-teaching model rather than a demonstration model. As mentioned previously, in two of the research sites there was almost a complete sharing of materials and lesson plans. In study F, the classroom teacher was observed saying the same thing, almost at the same time; as the resource teacher due to using the same lesson plans but both seemed unaware of each other.

The team-teaching situation is perhaps the best that can be devised for carrying programs into the classroom. The team situation allows the resource teacher to perform as a professional educator in a controlled situation and allows s/he to use methods and materials developed in inservices and to be there to detect difficulties teachers and/or students may have in utilizing a program. A team-teaching situation lasting over a number of days may improve the morale of resource teachers by allowing them to develop lessons that more precisely matches the needs of students and also permits the resource teacher to follow student progress in concept development. For instance, in Case Study I it was several days before the resource teacher began to use activities that were both challenging and achievable by a group of low achievers. Then too, if the resource teacher's visit lasts only one day, the activity taught is more likely to be viewed as an extra frill by the classroom teacher rather than a bonifide way to develop a mathematics program. Then too, the mathematics specialists in our project disclaimed the "specialist" part of their job title, indicating the possible unease school people may have regarding a role that might be considered one of dominance rather than of equalitarian collaboration.

TEACHER EVALUATION OF THE INNOVATION. In several of our case studies (A, B, G, H, I) we found that the teacher evaluated student learning soon after the unit, using manipulative aids and resource teacher help, was completed using informal tests including those found in the textbook. If students performed well on the subsequent tests teachers accepted both the new approach and the results as valid (B, G, H). However, if students did poorly on paper and pencil tests, this was taken as an indication of the failure of the method for producing improved achievement, a failure that was especially disappointing because of the time consuming nature of the activities program (Cases A, I). This use of tests by teachers for evaluating the program was unexpected, as tests had been deemphasized in the inservices. However, teachers apparently were responding to pressures beyond curriculum resource circles in the importance they placed on test results.

NON-UNIFORMITY OF TREATMENT. Program "treatment" was found to be non-uniform. There were a wide variety of local school and classroom contexts and extenuating circumstances influencing implementation. For instance, six classrooms were located in buildings with new or changing principals during the study. One school changed location and others were being entirely reorganized to facilitate desegregation. Some classrooms had competent, stable paraprofessional assistance in implementing the program (Sites B, G, H). Other classrooms had aides who were often absent, quit, were new and untrained or who left during the math period (A, D, E, F, I). One classroom had no adult help except for an occasional parent or project specialist (C), while one classroom had three adult assistants (H)--a project assistant, a regular volunteer and aide, during program implementation. Extra adult supervision during small group instruction, and especially in using math games, was found to be very beneficial to program implementation.

There was a wide variation in allocated time for mathematics, ranging from thirty minutes to an hour or more in primary grades and from one hour to two or more hours in intermediate grades. This latter was observed in a classroom typified by multiple groups of children coming and going to various pullout programs during the mathematics lesson. There also appeared to be a wide variance in curriculum scope, e.g. the number of concepts, terms and complexity of mathematics skills, covered on a topic among classrooms. (Our data is too limited, and also affected by time of year, to more than raise questions about this.) For instance, in one Grade 4/5 room the fractions unit was limited to the 8's family, in another fractions up to 25/25's were covered; in one Grade 2/3 classroom the 0 and 2 addition facts were covered; in another all facts up to the 9's were covered. These differences may be reflective of achievement outcomes and scores on standardized tests.

Finally there was a wide range of direct services, four to fourteen, provided to target students by Mathematics Project Specialists in anyone classroom during the year.

Issues Suggested by the Themes in This Study Regarding Implementation

One feature of ethnography is that it provides a database that can be used in multiple levels of analysis to answer a variety of questions some of which may emerge after the data collection phase is completed. Unlike an ethnographic study regarding a distant primitive culture, this study and others like it, may be immediately relevant to policy decisions and therefore can have undeniable implications, politically. Because of this it is especially important to stress the limitations of the study, e.g. a small self-selected sample, limited time frame, only experienced teachers participating, etc., when describing themes in the data and in addressing questions raised by the study. It is especially important that these results not be taken out of context as a national debate develops about the future of categorical aid programs in education, (of which ESEA Title I is the largest). However, in recognition of the political context in which this study may be viewed, an abbreviated statement regarding the larger political context is given below.

Our study, as was the program it evaluated, was designed to explore further the character of mainstream Title I programs in the classroom. Our bias has been to support the intent of mainstream programs, i.e., to improve the educational opportunity of low achieving students within the regular classroom, thereby offsetting the possible detrimental effects of pullout programs (for a fuller discussion of mainstream vs. pullout, see Glass and Smith, 1977; Cooley, 1981).

The results described as themes suggest that in order to improve the quality of the instructional program, for any group of low achieving Title I students within a classroom context, the Title I program "treatment" must take the structure and organization of classrooms into consideration in all stages of implementation. Teachers plan their instructional programs for entire classes, including grouping practices. In order to be effective, any mainstream program has to be planned within this total classroom group context. This has implications for a reinterpretation or modification of regulations regarding the administration of compensatory education programs. Some critics of mainstream approaches to Title I have complained that benefits intended only for the very low achievers identified as Title I target students will accrue to nontarget students in a Title I classroom program. However, the nontarget students may also be below average in achievement. We have found in our study that the so-called target group is a "moving target;" in other words, the group identified as low achievers in one mathematics area, e.g. multiplication, may not be the same group of children as those identified as low achievers in another area later in the year, e.g. fractions. This has been a well-known problem with any rigid categorizing of students into ability groups, a fact disregarded by those responsible for writing the Title I regulations. A classroom level program, where classroom teacher, resource teacher and instructional aide team to improve the instructional program may not only be an effective way to improve instructional delivery services to low achievers, it may also be a step towards improving the basic skills of students generally. Bossert (1979, p. 94) suggested that social relationships resulting from small group, multi-task instructional organization may have a direct and positive influence upon student achievement. Further, the ethos of American education requires equal treatment of everyone in the room; it is awkward if not repugnant to provide attractive and challenging services to some children and deny them to others within the same classroom as would be required by a strict interpretation of Title I regulations. It can be argued that in many situations, without compensatory assistance to low achievers, the most valued classroom attribute, i.e., teacher-student dialogue, is allotted disproportionately to higher achievers. If classrooms and/or schools were targeted for Title I services rather than individuals, the result might be more effective programs. This recommendation was also made by Cooley (1981).

A note on limitations. In discussing the limitations of an ethnographic study it is important to distinguish between the traditional scientific paradigm and the naturalistic paradigm in determining the credibility of findings. Both Guba and Lincoln, (1981) and McCutcheon, (1981), emphasize the importance of triangulation or convergent validation of findings in qualitative research. In this study various processes, including ethnographic interviews of participants, discussions of patterns observed among researchers in various sites, observations over a period of time, and teacher review of data, served to cross validate interpretation of the data. In this way, protocol data is not mistaken as "reality" but is viewed as one facet of a data collection process intended to produce "thick description" defined by Geertz (1973) as an explanatory interpretation of the phenomenon observed. In this sense the interpretation suggests why the pattern of behavior occurs as it does within the context of the study. Therefore, situational variables such as teacher experience, observations of only one period out of the school day, teachers trying out a procedure or program for the first time, other adult assistance in the classroom, etc., are important in interpreting this report. McCutcheon (1981, pp. 5-6) suggested, "Understandings can also lead us to alter how we view and conceive of a situation, causing researchers to change the nature of the questions they ask, after reading a particularly provocative, powerful interpretation."

The final section of this paper summarizes some steps to be followed in using ethnography for evaluative research in school districts.

A Model for Conducting Classroom Ethnographic Evaluation Studies By and Within School Districts

This is an abbreviated account of a suggested research agenda for use by school district evaluators in developing and conducting classroom ethnographies to be used for educational program evaluation. The model is interdisciplinary and is based upon concepts derived from anthropology, ecological psychology, teacher effectiveness research, sociolinguistics and the educational evaluation literature to the extent that they can be applied by a school district evaluator who is him/herself, a participant of the school district community. The model, as stated here, is elucidated by the body of this report and other reports regarding the NIE grant which is funding this research. Perhaps the best single reference for conducting ethnography in the schools is Cassell (1978) A Fieldwork Manual for Studying Desegregated Schools.

1. Evaluators Network

   It is strongly recommended that an evaluator establish his/her credibility within a school district for a year or more before attempting to implement an ethnographic study. Further, the support of the project coordinator and of central administrative curriculum personnel is essential.

2. Informed Consent of Participants

   Classroom ethnography relies upon the teacher volunteer; the voluntary context of the research forces the creation of a very special research environment of interdependent actors. As a part of obtaining informed consent, candidates for participation must be informed of the central purposes of the research and also of the responsibilities, limitations and consequences (if any) of their participation. As in oral history, care must be taken that research reports about the study are not harmful to the participants. In our study we assured teachers of confidentiality which follows both the ethics of ethnography and of program evaluation, which clearly eschews personnel evaluation (Standards for Educational Evaluation; Stufflebeam et al., 1978). The principal investigator and ethnographic assistant met after school to discuss and plan the research agenda with each teacher. We found it helpful to send a letter explaining the parameters of the study as a followup (Appendix D).

3. Maintaining Confidentiality

Cassell (1978, p. 77) noted that because of the continuing relationships formed between observers and participants at the site, heeding strictures regarding confidentiality become increasingly important over time. Ethnographers observe or are informed of many kinds of information which otherwise would not be known by outsiders. Preserving the confidentiality of informants, including children, is crucial to both the ethics and validity of the study. Decisions regarding the use of some types of "private" information are not easy and judgment may dictate that certain bits of information not be included in a study even when relevant. Usually, studies of this type are rich enough without the inclusion of "private" data.

4. Ethics

The ethical basis for ethnographic research was described in the previous sections on informed consent and confidentiality. The research site, e.g. public schools, must be kept open for future research. There are ethical issues and/or considerations also in the way observations are conducted, the way reports are slanted, review procedures available for teacher collaborators and provision of feedback to teachers. Our concern was to not only be as unobstrusive as possible in the classroom but to make those being observed as comfortable as we could in order to preserve an anxiety free environment.

In scheduling observations four days a week or less we attempted to be sensitive to a teacher's need to not be observed at any particular time. We instructed the observers to never write down anything while they were in the classroom that would be upsetting or embarrassing to the teacher or students. The protocols that were written later were to separate-out ethnographers opinions, judgments and hypothesis from the main report of ongoing events. (We asked teachers to review the protocols from their classrooms and the results of the study at the close of the school year.) Feedback to teachers during the study was not about evaluative judgments but consisted of dialogue about ongoing events and also some discussion of their perspective about an emergent hypothesis concerning some process, including their use or modification of the innovation. Teachers were treated as collaborators, not subjects, in the study.

5. The Viability of the Program Being Evaluated

An ethnographic study, because of its expense, human-interaction and involvement, and close scrutiny should only be planned if the program to be evaluated is viable in at least one of the three senses of the word as defined in the Oxford American Dictionary, (Ehrlich et al., 1980):

1. (of a fetus) sufficiently developed to be able to survive after birth.
2. (of a plant) able to live or grow.
3. practicable, able to exist successfully, a viable plan. . .

6. Program Evaluability

The question of evaluability, or whether a program is specific and structured to the point where it can be evaluated is complex. However, ethnography can be used in situations where other kinds of preset evaluation techniques would be inoperable. The answer regarding whether an observational study can be rationally implemented in a particular context will depend to a certain degree upon the persistence and facility of the evaluator in working with program implementors and recipients, and also to a large extent on the attitudes of both towards the possible benefits of the program for students (which again suggests the importance of program viability). Establishing a research observation schedule was not easy in the fall phase of our study, as can possibly be expected in a mainstream program, but the high regard of the teachers towards the potential benefits of the Title I mathematics services helped us to implement the research as well. Teachers were also interested in participating because of their support for alternative evaluation strategies, including their encouragement of a person from central administration spending time in classrooms and because they were interested in a reflective view of their own teaching.

7. Curriculum, Not Interpersonal Relations, Emphasis

We feel that ethnographic evaluations of a curriculum area, e.g. a reading program, math program, etc. will find easier acceptance, be more practical to carry out (because the observations cover one period not the whole day) and will produce the most readily usable results, for use in evaluation studies.

8. Staffing

The employment of partttime personnel to serve as ethnographic assistants to the evaluator proved to be the single most important feature of the staffing plan. The ethnographic assistants carried out scheduled systematic observations, with a concentration of site observations and regular report writing, which could not possibly have been carried out by senior evaluation personnel responsible for multiple projects. For instance, each hour of observation required approximately three hours of write-up time. Furthermore, the ethnographic assistants (EAs) had the time to continually maintain and renegotiate rapport with persons at school sites. Because there were three EAs the study could be carried out at several sites simultaneously.

Selection criteria for ethnographic assistants included (1) background in the social sciences, (2) ability to develop and maintain good interpersonal relations, (3) experience in teaching and in the curriculum area studied, and (4) well-developed writing skills.

An ethnographic project is paper, writing and typing intensive. Adequate secretarial support for the project is very important.

Consultants from the fields of educational psychology and educational anthroplogy helped to provide a training program for classroom observers in which program implementors were also included. Further, a different and potentially more powerful situation for evaluation resulted from discussions of program implementation among the evaluation group (principal investigator-evaluator, ethnographic assistants and consultants) and program implementors than normally occurs between a single evaluator and a number of program implementors.

9. Training Observers and Implementors

It has been widely recognized that the training of observers for naturalistic studies is crucial to the quality of the data, as well as to the maintenance of rapport with persons in the field. The training program also has to be designed appropriately for the educational level and background of the observers (ours all had masters degrees).

The training program emphasized the subtleties and factors of introducing an innovation into the classroom (an aspect of the training program especially meaningful to the implementors) as well as (1) the context and background of the program to be evaluated, (2) establishing and maintaining rapport with classroom teacher collaborators, (3) focal points for observations and (4) writing protocols. Notebooks containing a sample from ethnographic studies and writings on methodological issues were provided to the observers and implementors and discussed. (Teachers were not included in the training in our study because of logistics; teachers were not selected for the study until after the training sessions which occurred after school opened in the fall).

An important aspect of the training was the ethics of ethnographic research, especially regarding anonymity of participants. A coding system was established for use in writing protocols to preserve anonymity. A form was devised for hand-written narratives similar to that used by Evertson at the University of Texas. Examples of protocols given in the Evertson study and also by Ray Rist in the BTES were invaluable in providing models for the ethnographers to use in writing narratives. Later, we developed our own models for writing protocols. We also found that actual classroom observations rather than videotapes were more useful in training the ethnographers.

The ethnographic assistants also observed and were participants at the mathematics inservice workshops provided for project teachers. This served the dual purposes of documenting intended program implementation communicated to teachers and to further sharpen observational skills in the area of mathematics.

A nonjudgmental, distinctly anthropological approach to observing and describing classroom scenes and program implementation was maintained throughout the training sessions and during the study. (This was described in greater detail earlier in this report.) We found it relatively easy to train the EAs to produce eyewitness level protocols of classroom events; it was relatively more difficult to have them produce "thick descriptions" containing hypotheses about patterns or relationships in the behaviors observed. Periodic informal meetings between the principal investigator and EAs, during which classroom and program implementation events were discussed, proved invaluable to developing richer insights about the study.

10. Setting the Context with Program Implementors, Building Principals, Teachers and Students for Conducting An Observational Study

In conducting an ethnographic study of resource service delivery to classrooms it is very important to work very closely with the project coordinator and resource staff. The nonjudgmental, descriptive and collaborative framework of the ethnographic approach (vs. the personnel evaluation approach) must be clearly articulated. The selection of teachers as candidates for collaboration with researchers should be done in a way that the teachers have a real option not to volunteer. For this reason we contacted teachers ourselves, (after clearing the possibility of a research project with the principal) rather than having the principal request that teachers participate. We also selected teachers who the resource staff felt comfortable working with and who were experienced and capable. The conditions and limitations of the study were carefully discussed by the observers and teacher before any observations occurred. Teachers explained the observers presence in the room to students as someone who is interested in how children work and sometimes made name tags for the children to wear during the first day or two to identify students. The observers reported that after a day or two children seemed not to notice the presence of the observer, although there was some initial interest in the notetaking (one reason to keep notes as bland and nonjudgmental as possible).

In establishing themselves in the field, the observers attempted to develop a dialogue between themselves and the teachers regarding ongoing classroom events. This served to enrich the observations as the teacher became an informant for the study and also this shared perspective gave the teacher some indication about the content and focus of the observations.

11. Duration of the Study and Scheduling Observations Around Implementation

One reason that may have accounted for our success in obtaining teacher volunteers for the study was that we restricted the study to 20 observations or a four to five week period, and observations occurred mainly during only one period, the mathematics period. The observation schedule of conducting observations before, during and after resource teachers were in the classroom was an efficient way to study program implementation. Coordinating the research agenda with the resource teachers also provided insights into the service delivery mechanisms of the project.

12. Data Collection

The protocols contained (1) an overview or abstract of the focus of that day's observation, (2) detailed description of classroom organization and instruction and students involvement and response to instruction, and (3) comments or insights of the observer about the meaning of what had transpired. The protocols were written up daily and/or weekly and were given to the principal investigator for review, comments, and questions. After the study was completed at each site, the ethnographer summarized it and planned a final interview with the teacher during which the program would be discussed and her/his reactions to tentative hypotheses. Later in the study, teachers reviewed protocols and the final case studies. This not only provided feedback to teachers but assisted in validating the findings.

13. Levels of Data Analysis: Time Constraints on the Analysis of the Data

It is a well-known fact that evaluation research functions in a context of severe time-constraints; conversely, ethnographic studies are notoriously time consuming to analyze and write up. Therefore it is necessary to plan several stages of analysis, some of which can be ongoing during the course of the study. It is particulary important to review the protocols as they are produced to determine whether data on relationships of emergent interest in the study are being collected, and also to generate hypotheses. As themes begin to emerge in the data during the study, it may be possible to use methods of triangulation or cross-validation in various settings to test hypotheses. Porter-Gehrie and Crowson (1980) suggested that early data samples be collected around focal issues and later analysis occur about case studies and the meaning of relationships across case studies. In our study we produced case studies of each site using excerpts from protocols before, during and after program implementation in the classroom to be used for feedback to teachers and to provide documentation for later synthesis of findings. The case studies, which we had envisioned as about eight pages in length, turned out to be from 13 to 30 pages in length in an attempt to present enough of the protocol data to preserve some of the richness of complex classroom processes and to avoid appearing to over-generalize from the data. The case studies variously provided information useful to others seeking to implement the program, gave rich descriptions of classroom organization and program implementation, and provided insights into the needs of target students. They, on the other hand, were time consuming to produce in a synthesized form and could possibly be replaced simply by the case file of protocols. A general report organized around themes with examples from various sites is far more useful for immediate use in a program evaluation report than individual case reports. However, the case studies provided a necessary analysis of protocol data upon which to base a curriculum evaluation of some of the substantive aspects of the program, and provided a helpful tool in developing a separate report on the mathematics learning of program participants. As time and resources permit, the case studies provide a productive method of analysis. The ethnographic assistants reviewed each protocol and wrote analyses of their case studies.

14. Reporting Results

In preserving anonymity of participants while remaining "true to the data" it appears more useful and practical to develop the latter, e.g. reports developed around themes with relevant examples from different sites, than geographic site studies. This type of report also may be more readable and useful to various audiences since case studies often must contain a great deal of detail to be useful.

There is a need for feedback to participants. It is suggested that collaborating teachers be given an example of a protocol before the observation study begins. It may also reduce teacher anxiety if teachers have a chance to read one or more protocols during the observational period. However, premature sharing of findings may interfere with the "natural course" of events being observed. At the end of the school year a research colloquium was held for classroom and resource teachers to review the findings and to read protocols from their classrooms (see Appendix E for the agenda). Teacher's responses to the protocols were very positive. The colloquium also provided an opportunity for teachers to have input into the interpretation of the data and make recommendations regarding future development of the project. It also provided a forum for discussing results among researchers, teachers and administrators.

15. Caveats, Difficulties and Things Not To Do

From doing fieldwork to setting up the logistics for the study to final report writing there are a number of pitfalls to be avoided. Space does not allow their enumeration here however in planning this present study several references were extremely useful. Guba (1980) warned that evaluation may be dysfunctional to performance and that anxiety may be one of the spinoffs from evaluation. Therefore the value and potential utilization of the information to be gained from a study must be a good trade-off for the imbalance that it may cause. Also evaluators must be prepared to take steps to alleviate anxiety as much as possible that is caused by the study. The elaboration of problems encountered in a study by deVoss, Nott and Zimpher (1980), especially their warning about not overemphasizing the legal or potential risk factor in obtaining informed consent, was instructive for this study. Also noted in several studies was the need to replace observers during the study, something that we had to do in January. We found that the already trained observers were helpful in training the new member of the staff.

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Table 1
Observation Schedule for the NIE Classroom Implementation Study

Case Study	Grade(s)	Time of Year	Days	Hours	Minutes
A	4/5	October 6 - November 5, 1980	13	17	11
B/C	2/3	October 13 - November 10, 1980	13	13	7
		and March 11 - April 1, 1981	5	5	11
D	2/3	October 20 - November 12, 1980	10	7	44
E	5	January 19 - February 16, 1981	16	21	25
F	4/5	January 26 - February 25, 1981	15	16	25
G	3	February 25 - March 30, 1981	10	11	55
H	3	January 28 - February 26, 1981	14	14	46
I	4/5	March 6 - 26, 1981	10	10	--
		TOTAL	106	118	11

APPENDIX B

Narrative Form - Classroom Ethnography

Page____of____

Date_______________ Teacher Code #_________ # Aides Present_________

Beginning time_________ Observer Code #_________ # Parents Present_________

Ending time__________ # Students Present______ # Others Present_________

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
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TUSD L&R
10/13/80

1-42

Narrative Form - Classroom Ethnography

Page_____of_____

Date____________________ Observer #__________________

1. ____
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TUSD L&R
10/13/80

APPENDIX C

AGENDA

Program for Training Ethnographic Assistants[1]

NIE Classroom Implementation Study

9/22/80 Monday	8:30 - 8:45	Introduction and Getting Acquainted (Helen Slaughter)
	8:45 - 9:30	Orientation to the Research Study: a) Purpose, b) Scope, c) Developing an Ethnographic Model for Studying Program Implementation and d) Ethics in Ethnographic Research (Helen Slaughter)
	9:30 - 10:00	Orientation to the Title I Mathematics Project 1) Approach to mathematics education of the project 2) Ways of working with classroom teachers (Title I Mathematics Project Specialists)
	10:00 - 10:15	Break
	10:15 - 11:30	Ethnography (Jack Chilcott)
		Suggested readings: Bawden, Robert, Susan Florio and Donna Wanout. "Learning from Teachers: Lessons about Professional Development Drawn from Teacher Participation in Research and Evaluation."
		Carrasco, Robert. "Expanded Awareness of Student Performance--A case Study in Applied Ethnographic Monitoring in a Bilingual Classroom."
		________. (Ethics) Appendix 2 "Teaching As A Linguistic Process--Mid-Project Report, V. Koehler NIE Project on Teaching and Learning."
		Geertz, Cliford. "Deep Play: Notes on the Balinese Cockfight." The Interpretation of Cultures.

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[1] Note: Training will include dicussions of some of the suggested readings.

9/23/80 Tuesday	9:15 - 10:15	Videotape: Mathematics Demonstration for TUSD Teachers (Mary Baretta Lorton) Developing Observational Strategies Focusing/selecting topics to be included in Narratives Notetaking vs. summarizing skills (David Berliner)
	10:15 - 10:30	Break
	11:15 - 12:00	Sociolinguistic framework for studying classrooms; social interaction and context (Helen Slaughter) Suggested readings: Rist, Ray. Ethnographic Techniques and the Study of the Urban School. Mehan, Hugh. Learning Lessons: Social Organization in the Classroom.
9/24/80 Wednesday	8:30 - 9:30	Videotape of a Third Grade Mathematics Classroom Lesson: Discussion (David Berliner) Development of Behavioral Indicies of Implementation (David Berliner)
	10:15 - 10:30	Break
	10:30 - 11:30	Non-Participant/participant observation and information gathering--etic and emic approaches (Jack Chilcott) Suggested readings: Behr, Merlyn J. (Case Study of One Child) Teaching Experiment: The Effect of Manipulatives in Second Graders' Learning of Mathematics. Smith, Louis. An Evolving Logic of Participant Observation. Rist, Ray, C. and William J. Tikunoff. Manual: Ethnographic Observation in the Classroom
9/25/80 Thursday		No meeting: Ethnographic Assistants attend mathematics workshop for Grade 3 teachers 8:30 - 11:30, Room 302, Roskruge

9/29/80 Monday	8:30 - 9:30	Discussion of Ethnographic Assistants Impressions of the Study to Date
	9:30 - 9:45	Break
	9:45 - 11:00	Classroom Ethnography (Jack Chilcott)
	11:00 - 11:30	Entry and Establishing Oneself in the Field (Helen Slaughter)
		Suggested readings: Wolcott, Harry. The Elementary School Principal.
		Carew, Jean V. and Sara Lawrence Lightfoot. Beyond Bias: Perspectives on Classrooms.
9/30/80 Tuesday		No meeting: Ethnographic Assistants observe mathematics lesson in classrooms not participating in the study.
10/1/80 Wednesday	8:30 - 10:00	Discussions of Ethnographic Assistants Classroom Observations
	10:00 - 10:15	Break
	10:15 - 11:30	Possible Effects of Introducing an Innovation into the Classrooms (Jack Chilcott)
		Suggested readings: Fullan, Michael and Pomfrel, Alan. Research on Curriculum and Instruction Implementation (Excerpt: Determinants of Implementation) Review of Educational Research. Winter 1977.
10/6-8/80 Monday - Wednesday		Two days of observation experience for ethnographic assistants (EA). Two EAs observe in nonparticipating classrooms, one observes in a research site classroom.
10/13/80 Thursday		Training session with PI and consultants. Group reading and discussion of EA protocols from previous weeks observation.
		PI observes in 2 research site classrooms at same time as EA followed by consultation discussion of focuses of observation discussed in the study.
10/21 or 23/80		EA attend Title I mathematics inservices with teacher collaborators.

10/23/80	PI meets with EAs to coordinate and discuss the research.
10/31/80	Research meeting, PI, consultant Jack Chilcott, 1 Title I mathematics Resource Teacher and the 3 EAs to discuss the classroom observations, specifics of services offered by Title I resource teachers to classrooms.
11/20/80	Training in ethnographic interviewing techniques.

APPENDIX D

TUCSON UNIFIED SCHOOL DISTRICT
P.O. BOX 40400
1010 EAST TENTH STREET
TUCSON, ARIZONA 85717

1-47

January, 1981

Dear

Thank you for volunteering to participate as a teacher collaborator in the Classroom Implementation Study of A Supplemental Mathematics Program, funded by the National Institute of Education (NIE) under the Teaching and Learning Grant.

We plan to begin our observations of the mathematics program in your classroom soon. The observations will occur three or four periods a week for approximately four weeks. All observations are to be scheduled at the teacher's convenience and fit into your schedule. We will check with you weekly and daily to schedule the observations. Observations may be cancelled whenever inconvenient for the teacher and observations will not occur when there is a substitute teacher. The maximum number of observations is 20, including four observations which I plan to conduct personally. Confidentiality and anonymity is assured for all participants.

The observers have all been teachers and have worked in the schools. They have been trained in ethnographic observation techniques and will be as unobtrusive as possible. During their first two weeks in your classroom they will be focusing upon the total environment and also trying to learn the names of Title I math project participants, for whom they will have a list.

We would like to thank you for your willingness to participate in this study by paying you at the consensus rate of $11.00 per hour for any extra time you spend discussing your program and students with myself and/or the observer either after school or during break times, etc. We have a budgeted amount of NIE funds for this purpose. We also have two days of released time substitute pay which may be used for you during the study to facilitate the research (this is optional based on your own interests and availability). We hope to use a part of this to provide feedback to you regarding the results of research done in your classroom, and also to give you a chance to review and make comments concerning the research.

Thank you again for being a part of our research team. If there are any questions or concerns about the study as we go along please call me at 791-6138.

Sincerely,

Helen Slaughter

Helen B. Slaughter
Principal Investigator
Classroom Implementation Study of
  An Activities-Based Supplemental
  Mathematics Project

HS/ch

AN EQUAL OPPORTUNITY EMPLOYER

APPENDIX E

CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED MATHEMATICS PROJECT

NATIONAL INSTITUTE OF EDUCATION
TEACHING AND LEARNING GRANT FY81

TWO-DAY COLLOQUIUM

For Teacher Collaborators,
Resource Teachers and Researchers

Tentative AGENDA

and

Tentative DATES May 28 and 29, 1981

Thursday, May 28

Health Foyer
Education Center

8:30 to 9:00

Helen Slaughter meets with teacher collaborators and presents overview of process used to make observations, suggests things of interest in protocols and gives an explanation of codes, etc., used in writing protocols. Protocols will be indexed and organized as follows:

1. Observations before the MPS enter the classroom.
2. Observations during MPS classroom services.
3. Followup observations.

Teachers are given protocols describing their own classrooms to read and review for the following purposes:

1. Feedback to teachers regarding observations made in their classrooms.
2. To obtain teacher consent to publish the protocols as part of a NIE report and to provide a database for sharing with other educators and/or researchers. Teachers are asked to mark any objectionable (e.g., identifiable) material for deletion.

9:00 to 12:00
(Including Break)

Teachers read and review protocols.

12:00 to 1:00

Lunch

Room 210
Education Center

1:00 to 2:45	PI, EAs, teacher collaborators and resource teachers--Abstract of Tentative Results of Study reviewed. Three-way discussion of outcomes of study (taped) regarding: 1. Title I program implementation in the classroom. a. Classroom teacher contingencies. b. Resource teacher contingencies. 2. Conducting observational studies in the classroom to study curriculum implementation (including appropriate feedback to teachers and others). 3. The Title I project approach to mathematics. 4. Title I math project impact on specific individual students.
2:45 to 3:00	Break
3:00 to 3:30	Time for further reading of reports if needed.

Friday, May 29

Room 502
College of Education
University of Arizona

8:30 to 9:30	Third grade and fifth grade teachers meet in separate groups to develop a written plan for classroom teacher-resource teacher collaboration in improving the quality of educational programs for low-achieving students: a listing is provided of areas to be covered. Resource teachers meet in a group.
9:30 to 9:45	Break
9:45 to 10:30	Conference--groups present their plans to total group. Discussion and finalization of overall plan drawn up.
10:30 to 12:00	NIE Math Project consultants, Dr. David Berliner and Dr. John Chilcott meet with group to discuss the research. Dr. Berliner will place this research study into the context of other research studies of classroom teaching. Dr. Chilcott will describe program implementation as viewed by an educational anthropologist. Advisory Committee members may attend although this session is not an Advisory Committee meeting.

12:15 to 1:30	Lunch
1:30 to 3:00	Advisory Committee Meeting: Results and Implications of Study (abstract provided). Participants: Advisory Committee Members Consultants Ethnographic Assistants Math Project Specialists Teacher Collaborators Title I Project Specialist, Research Site H

TUSD L&RS
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Revised 4/21/81
Revised 5/20/81

Classroom Implementation Study of An Activities-Based Supplemental Mathematics Program

PART TWO:

MATHEMATICS LEARNING OF LOW ACHIEVING STUDENTS THROUGH MATHEMATICS GAMES AND OTHER MANIPULATIVE AIDS

Final Report to the
National Institute of Education
United States Department of Education

Helen Slaughter, Principal Investigator
Department of Legal and Research Services
Tucson Unified School District
Tucson, Arizona 85719

Lisa Leiden, Barbara Markert, Peggy Placier
and Judy Walters, Ethnographic Assistants

NIE Teaching and Learning Grant G-80-0090
August 1, 1980 through July 31, 1981

SE037088

CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED SUPPLEMENTAL MATHEMATICS PROGRAM

ABSTRACT

This research described the classroom implementation of a supplemental activities-based mathematics project designed for low-achieving students. The research describes the development of applied ethnographic methods for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. A model for use by school district evaluators in conducting ethnographic evaluation studies was developed.

The research consisted of ethnographic observations of mathematics lessons and student learning in nine classrooms in Grades 2 through 5 in eight schools serving low-income attendance areas. Observations were conducted over approximately a five-week period by four trained ethnographic assistants. Observations were scheduled before, during and following the delivery of classroom services of Mathematics Project Specialists.

Protocols of each observation, including those of the mathematics inservices, served as the basis for case studies produced for each of the eight sites.

Themes emerging from the study indicated that the predominance of classroom structure, the conditional nature of classroom teacher-resource teacher collaboration, teacher inservice, and teacher's evaluations of subsequent student achievement growth were key factors in program implementation.

Ethnographic descriptions of mathematic classroom activity structures provided a number of insights into the contribution of mathematic games and other manipulative aids to the learning of low-achieving students.

CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED SUPPLEMENTAL MATHEMATICS PROGRAM

Executive Summary

This research describes an in-depth classroom implementation study of a supplemental activities-based mathematics project designed for low-achieving minority students. The research supplemented existing evaluation procedures to allow for the development of applied ethnographic methods in program evaluation. The focus of the study was the development of procedures for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. The study also addressed questions arising in practice and in the research literature about the mathematics learning of low achievers in an instructional program using manipulative aids.

The research consisted of ethnographic observations of mathematics lessons and student learning in nine classrooms in eight schools serving low-income attendance areas. Observations (10-15) were conducted over approximately a five-week period by three trained ethnographic assistants. Classrooms observed were Grades 4/5, 2/3, 2/3 and 2 (fall), Grades 5, 4/5 and 3 (winter) and Grades 3 and 5 (early spring). A brief followup study occurred in spring in one Grade 2/3 classroom. Observations were scheduled before, during and following the delivery of classroom services of Mathematics Project Specialists.

An ethnographic methodology was used in an attempt to generate hypotheses, and accommodate the research to natural classroom and program implementation processes. While a number of research questions served to focus observations, an attempt was made to produce protocols that were richly descriptive of the classroom structure and interactional processes as they happen.

Protocols of each observation, including those of the mathematics inservices, served as the basis for case studies produced for each of the eight sites. Both the protocols and case studies were reviewed by teacher collaborators during a two-day research colloquium. The case studies presented a variety of classroom mathematics activity structures occurring over a period of a four- or five-week time span and illustrated the use of manipulative aids and games and student responses to them, in a variety of contexts. Data presented in the case studies suggested that the successful participation of low-achieving students in the instructional process is increased by a multigroup, multitask structure when teaching with manipulative aids.

A number of themes emerged from the study regarding program implementation. Major themes include the following:

1. The ambiguity of the resource teacher role resulted in a wide variance in the scope, structure and quantity of services to different classrooms. Offsetting this were carefully planned, well-articulated half- and whole-day mathematics inservices. Teachers felt the inservices were an essential element in enabling them to implement the program.

2. There were a number of conditions to classroom teacher, resource teacher collaboration. These included teacher control of the classroom, group management, content to be taught, amount of time to be spent in the classroom and sharing or nonsharing of methods and materials.

3. Preexisting classroom structure before entry of the resource teacher, and/or concern for total class management had a determinant affect upon how the resource teacher fit into the classroom.

4. The prototypic model for classroom teacher/resource teacher collaboration appeared to be that of a team teaching rather than a demonstration model. Although some other styles of direct services of resource teachers were observed, the team-teaching model seems to depict the most acceptable (to both classroom teacher and resource teacher) participant structure for the implementation of the resource teacher service delivery strategy.

5. Some teachers evaluated the effectiveness of an activities approach to mathematics, and of the resource teacher services with tests administered shortly after the delivery of resource teacher services. Student success or failure on the tests, despite some mismatch between the curriculum focus and test items was seen to be reflective of the effectiveness of the program. This was indicative of the need for appropriate and specially designed evaluative end-of-unit tests to be used by teachers in evaluating student learning.

6. Program "treatment" was found to be nonuniform. There were a wide variety of local school and classroom contexts and extenuating circumstances influencing implementation including, (a) wide variation in time allocated for mathematics, (b) stability/change of principal and faculty of school staffs, (c) extra adult assistance in the classroom for program implementation varied from none to three, (d) a wide range of direct resource services given to any one classroom from 4-14, and (e) there appeared to be a wide variance in curriculum scope, e.g., number of concepts, terms and complexity of mathematics skills, covered on a topic among classrooms.

7. The mathematics program was partially defined as it was being implemented. One value of direct services of resource teachers

has been to enable them to modify, refine and further develop the program as a result of their experience in the classroom.

The study provided a number of insights into the contribution of manipulatives and games to the mathematics learning of low-achieving students. The observational data suggested that manipulative aids such as Cuisenaire rods and pattern blocks were very appropriate for the instruction/learning of the low-achieving student. Often low achievers were more successful doing manipulative activities than other math activities. However, in using manipulatives for instruction, students must first be taught the meaning and use of the technology of manipulatives. The data provided numerous examples of teaching children the meaning of, and even how to construct, manipulative aids. Much guidance to individual students was observed in the use of this instructional strategy, and because of this, small-group instruction seemed more appropriate, especially for low-achieving students, than whole-group instruction.

The skillful use of manipulatives in instruction required a high degree of teacher/aide training. This was provided in the inservices, as a first step, (sometimes followed by demonstrations) and facilitated through the use of worksheets that could be used within the guided instructional process to help teachers structure the lesson. Some of the worksheets as well as other activities were invented by the resource teachers to help classroom teachers 'think like mathematicians' in the instructional process. Also worksheets were used to help students make the transition from the manipulative level to the symbolic level.

In most classrooms students were observed playing mathematical games. However the role games played in instruction varied, as did student response to the games. Teachers seemed to view games as either a teaching strategy, i.e., games were used as a part of instruction and learning new concepts and facts, or for use as maintenance of skills already learned. Sometimes games were used as an independent small-group activity but this was difficult to manage without the supervision of an aide or other adult in primary grades. Also groups of younger students, Grades 2-3, appeared to have difficulty in managing the competitive aspect of the games without supervision. Training in gamemanship appeared helpful and was sometimes provided by the resource teachers. Game playing of self-selected partners was more easily managed on an informal than an assigned group activity basis when adult supervision was unavailable.

Games appeared to be a potentially useful way to diagnosis individual skill attainment and give individual assistance in skill and concept development to small groups of students. When observing games used as a teaching strategy, it was clear that individual low-achieving students benefited from adult help.

This study describes an applied ethnographic model that can be adopted by school district evaluators to study program implementation within classrooms. The model describes (1) setting the context with program implementators, building principals, teachers and students for conducting an observational study, (2) ethics of ethnographic research, (3) training classroom ethnographers, (4) developing procedures for data collection and reduction, (5) analyzing the results and (6) reporting the results.

This research was divided into three sections; Part One: An Ethnographic Evaluation of Program Implementation, Part Two: Mathematics Learning of Low Achieving Students Through Mathematics Games and Other Manipulative Aids, and Part Three: Eight Disaggregated Case Studies.

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PART TWO

Mathematics Learning of Low Achieving Students Through Mathematics Games and Other Manipulative Aids

In an extensive review of the literature regarding the proficient use of manipulatives in mathematics instruction, Suydam and Higgins (1977) recommended that they be an integral part of instruction at the elementary school level. They even stated that any program not using manipulatives should justify why they were not used. However, they also admitted that the need for more research on the subject is recognized by all. Needed studies include description on the degree of teacher guidance given to students during the manipulative activity, transfer of concrete manipulations to symbolic records, the role of group size and social interaction in learning through manipulatives, length of time manipulatives are used and percentage of time manipulatives are used within a total mathematics program. For instance, Simpson (1974) found that at least 50 percent of the time should be spent on manipulatives to produce a treatment effect.

In a study of second graders' mathematics learning through manipulatives Berh (1976, p. 77) found that low-achievers' performance was superior in the enactive mode (using manipulatives) but that they had difficulty giving symbolic responses to similar questions. De Flandre (1974) found that second, third and fourth grade children who participated in a field study of a unit using manipulatives to teach place value could not transfer the concept of place value numeration systems to addition and subtraction at the symbolic level. In a counter example, Trask (1973) found that low-ability Grade 3 children did better on symbolic tasks and that the manipulatives were confusing to low achievers. This present study provides descriptive data on some of these concerns, and may serve to generate hypothesis and evaluation questions to guide further research.

Design of the Study

This study reports some emergent findings from a series of eight disaggregated single case studies of the implementation of an activities-based mathematics project with the classroom serving as a unit. Kennedy (1979) related the importance of the single case study approach for documenting the effects of treatment and also the reasons for these effects. Carrying on the study at multiple sites showed how the treatment functioned for different recipients, both students and teachers, in different contexts. According to Kennedy (1979) generalized statements regarding program effects are of limited validity because of the wide variation in treatments, intervening influences and extenuating circumstances in implementation. Attempts to clearly define any single program treatment and its affect upon achievement is further confounded when students participate in several programs including the specific program ongoing in the regular classroom. Statements of program effects in terms of gains scores aggregating student pre-posttest means across classrooms and schools are only meaningful to the extent that program implementation is uniform.

Method. Four ethnographic assistants were trained in ethnographic nonparticipant observation techniques and to produce narrative accounts of classroom observations based upon the work of Johnson and Gardner (1979), Tikunoff, Berliner and Rist (1975), Evertson (1980) and Cassell (1978).

Observations (7-16) were scheduled in either the fall, winter or spring in nine classrooms (see Appendix A for the observation schedule for the different grade levels included in the study). Observations focused upon classroom organization and structure, event analysis of instructional modules and student responses to them, and especially upon the responses of low-achieving students identified as Title I mathematics project participants.

Students identified as "low-achievers" in this study were students in Grades 3 and 5 referred by classroom teachers as having difficulty in mathematics and who scored low on achievement tests (stanines 1-3 on the California Achievement Test, Form C, Level 12 in Grade 3, or percentiles 1-17 in the beginning of Grade 4 on the Stanford Mathematics Test, for Grade 5 students). All students attended ESEA Title I schools typified by enrolling large numbers and/or percentages of low income, low achieving students; therefore, a number of other students in the classroom, not explicitly identified, were also low achievers. Low-achieving students were identified in the protocol data, excerpts of which are included in this report, by an asterisk placed before their name (with the exception of classroom D where all students were low achievers).

For purposes of studying program implementation, observations were scheduled before, during and after mathematics project specialists worked with small groups of low achievers within the classroom and case studies for each of the sites were prepared in this order. However, this sequence was not always relevant for the purposes of detecting patterns in the data regarding the mathematics learning of low achievers through the use of manipulatives in instruction. Detection of patterns regarding student learning and/or other responses to the activities in the mathematics program required a more careful analysis of descriptions of selected events, which we termed classroom activity structures (Berliner, personal communication). Activity structures described in the protocol data in each case study are summarized in Appendix B.

While one purpose of the study was to explore how variation in classroom contexts influences variation in implementation, another goal of this research was to search out similarities that cut across classroom contexts. In some of the examples listed below excerpts from several sites were found to illustrate certain patterns; in other cases, trends that appeared important to research in this area are illustrated from the data of a single case study.

Observations focused on natural classroom sequences with a deliberate attempt to not interfere with or alter the ordinary course of classroom events. Therefore the data are descriptive only, serving to suggest features of classroom activity structures that appear to be important in understanding an activities-based mathematics program and its affect upon students. These trends in the data may be useful for raising questions that could serve to generate hypotheses in further, more highly controlled studies. Sometimes patterns emerging from the data appear to take the form of a natural experiment either within or across sites. In fact, these 'natural' experiments are important to the detection of patterns in descriptive-qualitative data. A caveat, however, is in order in that a myriad of other variables could account for the observed patterns, and findings of this study need to be followed up by more controlled variation of treatments.

Findings

The results reported here are based upon insights gained in conducting the study, protocol data from classroom and inservice observations, and case studies, prepared as separate reports, for each of the eight research sites involved in the study. The case studies, providing an abbreviated and chronological summary of protocol data are referenced by the identifying letter for the site, e.g. A, B/C, D, E, F, G, H. Protocol and case study data, as well as the conclusions presented here were reviewed and discussed with teacher collaborators and three mathematics project specialists (MPS) participating in the study.

These results are organized around a few themes or interpretative trends observed regarding the mathematics learning of students engaged in a variety of mathematics activity structures within relatively typical classroom settings. Most of the activities described in the protocol data took place in small group structures, although a few describe whole group instruction. Excerpts from the protocols were included to highlight the importance of the "context" in which programs are implemented.

Mathematics activity structures described in the case studies which this report attempts to synthesize consisted of (1) 45 mathematics games, (2) 38 activities using manipulatable aids that were not games and (3) 22 examples of other mathematics activities, e.g. worksheets, teacher chalkboard demonstrations.

Activity structures involving manipulative aids were defined in this study as activities requiring the use of representational systems to demonstrate mathematics concepts, relations or operations through the use of concrete manipulatable objects or diagrams. The purpose of the manipulative aid was to provide students with models for conceptualizing mathematics. Mathematics games may utilize manipulatives in this sense but games were often designed for practice of facts at the symbolic or written level. Mathematics games are defined as an activity requiring the exercise of mathematics skill which involve more than one person and the element of chance.

MANIPULATIVES AS A HEURISTIC DEVICE. The protocol data suggested that representational systems as seen in mathematics games and other concrete manipulatives, were understood and used by students, including low achievers, in performing mathematical operations. However, in addition to assisting students in conceptualizing relations and performing operations, the representational system must also be learned. Sometimes the system used was simple and easily mastered; other times it was more complex and the system of meanings within the manipulative aid was taught and/or reviewed before being used in problem solving. In this latter sense, the manipulatable aid could be viewed as a technology that was taught and learned parallel to the mathematics content.

In the first example, Ms. L., a third grade Title I classroom aise is seen using egg cartons and colored beads to show children how to conceptualize and do multiplication. It also indicates that low achievers can be successful at this kind of task.

An example of a relatively simple representational system for multiplication:

> 11:03 Ms. L. the aide, had a new group started. Juan* was in the group. Juan* went ahead and filled in the first two rows, but hesitated with "2 x 0." He went back to it minutes later and wrote zero. When called on to answer 4 x 1, he said "4," but made the common error saying 4 ÷ 1 = 4. Mill correct him with 4 ÷ 4 = 1.
>
> Ms. L. called on Jackie*
> L : The number of boxes?
> Jackie*: 8.
> L : How many beads in each one?
> Jackie*: 1.
> L : The answer?
> Jackie*: 8.
> L : Write the answer down. A division problem?

Jackie*: 8.
L : Divided by.
Jackie*: 1.
L : Can you divide 8 by 1?
Jackie*: No.
L : So, 8 ÷ 8 equals what?
Jackie*: 1.
Al* was called on after a student gave the answer for 6 x 3.
L : Al*, do 5 x 2. How many boxes do you need?
Al* : 5.
L : And in each box?
Al* : 2 (beads)
L : The answer is?
Al* : 10.
L : Do the rest of you agree? (some do, some don't) Let's try a division problem.
Al* : 10 ÷ 5 = 2
L : Ok, 10 ÷ 5 = 2, or 10 ÷ 2 = 5.
Neither Al* nor Jackie* got ahead of their group, but worked each problem right along.

I waited to see Jackie* work another problem before taking notes. Her problem was 9 x 2.
L : Can anyone tell me the answer before Jackie* finishes (counting the beads)?
Sheryl : 18.
L : Is that correct?
Jackie*: Yes.
L : Ok, give us a division problem.
Jackie*: 18 ÷ 2.
L : equals.
Jackie*: 9.
L : How else could you divide this?
Jackie*: 18 ÷ 9 = 2.
(G, pp. 3-4)

In the second example, a third grade teacher was observed using Cuisenaire rods to teach multiplication. Several excerpts from a series of protocols are given to show this relatively complex representational system, which the teacher reviewed with the students each time before using for instruction.

An example of a relatively complex or technologocial manipulative aid:

The teacher, Mrs. R., used Cuisenaire rods and graph paper in introducing the multiplication facts. An example of teacher-target student dialogue follows:

T : How many spaces does each red represent?

Sts. : 2.
T : How many rods did you use Katie*?
Katie*: 7.
T : How many spaces are represented?
Sts. : 2.
T : 7 x 2 equals what? Katie*?
Katie*: 14.
(G, p. 2)

The next week, instruction in classroom G continued to focus upon the multiplication and division facts, now extending into the "3's" facts. Cuisenaire rods, graph paper and a short facts test was used as part of instruction. Students readily used the cuisenaire rods representing 1, 2, 3 but became somewhat uncertain of the value of the longer rods. As a review of the rod's values, students made a staircase of rods from high to low. There is some indication that the learning of spatial relationships exemplified in patterns made with cuisenaire rods was a separate but parallel process to learning to write out the facts symbolically. Cuisenaire activities were done regardless of children's mastery of fact sheets.

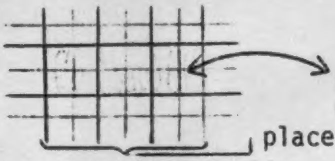
The following excerpt describes the classroom teacher's lesson on multiplication and division.

10:33 A new group of students joined Ms. R. She handed out sheets of math work and told the students to do the side with the plates. As quickly as they finished, she graded the papers, and told them to turn their paper over.
Ms. R.: Look at the first problem. What block equals 3?
St. : Light green.
T : What block is 2?
St. : Red.
T : How many spaces do the green take up? (on graph paper).
St. : 6.
T : There's our answer. 2 x 3 = 6. Write your answer and put a division problem below it. What's yours Lex?
Lex : 6 ÷ 2 = 3.
T : Good, on to the next problem.
(G, p. 5)

A different pattern was made with cuisenaire rods associated with multiplication concepts (than previously used with addition-subtraction concepts).

Bill : I can't get three on.
Maria : Look you're doing it wrong.

T : We're making crossroads not trains today.
Bill made several attempts. The right way was:



T : See how many whites or 1's you can put on the dark green; 6's.
(G, p. 5)

On the fourth observation day in classroom G, the aide was absent and Mrs. R. taught the whole group another lesson on multiplication and division using Cuisenaire rods, graph paper and a handout. While some students were very attentive to the lesson and followed through using every step of the process carefully when working at their desks, classroom management was more difficult without grouping and the aide's help. Children were first told the number of rods in each color required for the lesson, and then graph paper was handed out. Children were instructed to number rows and columns. Mrs. L. taught the children a technique for division by 1, 2, 3, 4 and 5. First students colored in enough squares to equal the number being divided, then the colored squares were covered with the rods representing the division. The number of rods required to cover all the colored squares represented the answer. Students were also shown the symbolic representation. Notice the response of Katie*, one of the low achievers.

T : Ok, on this paper (graph) color in 3 squares

This is the number being divided, so we color 3 squares. Now, it's divided by what number?
Grace: 1.
T : Which block represents 1?
Grace: White.
T : How many blocks do we need to cover it up?
Sts. : 3.
Ms. R. wrote the problem on the south board. . .

①

$$\begin{array}{r} 3 \\ 1\overline{)3} \end{array}$$

I noticed Katie* stayed right along with Ms. R., coloring each square, always using the Cuisenaire rods first, and writing in each answer. . .(G, p. 6)

Paper folding provided a relatively simple type of a manipulative aid that appeared effective in helping students understand fractional equivalencies.

An example of a relatively simple manipulative aid for teaching fractions.

> Mrs. Jones had gone on to the next step in the exercise, having the children "show" her fractions by folding the strips. For instance, she said, "Show me the fraction 3/8 by folding the family of 1/8's" or "Get your strip of 1/16's. Show me 4/16's." Tommy*, again the first to respond, said "Like this, Miss." (holding up his strip) Mrs. Jones said, "Ok if you're so smart, here's a tricky one. Fold the 1/2 strip back so you can only see 1/2. Then fold the 1/4 strip back so you can only see 1/4. Tell me something about these two." Margaret (her first response): "One's smaller." Mrs. Jones: "Which one?" Tommy* and Marta* in unison: "1/4". She asked them to fold the 1/4 strip so they could see 2/4's. Marta*: "That's the same, Miss." (comparing it with the 1/2 strip) Mrs. Jones: "Marta*, you stole my thunder! Now we can say 1/2 = 2/4." She had the children generate more equivalencies by folding the strips and comparing. (F, p. 10)

In the following example, from a fifth grade classroom, a manipulative aid of another type was being used. Pattern Blocks, used to help students understand fractions concepts, encouraged students to develop spatial thinking skills. Note that the representational meaning of each block must be taught prior to its application to understanding relations. This protocol also suggests the attractiveness of the Pattern Blocks to the children.

An example of a complex manipulative aid requiring spatial thinking:

> Barb, the Mathematics Project Specialist, asked five children to come to the oval rug in the front of the room. When they were seated, she passed out a Hexagon worksheet. The pattern blocks were in four piles in the center of their circle: yellow, red, blue, and green. First she told them to cover the hexagon on their worksheets with red pattern blocks. It took two. Then she held up a yellow hexagonal block, the same size as the hexagon on the worksheet, and said, "If this is the whole, what do you call this red one?" She asked again, what they would call one of "two equal pieces." Jerry* said, "1/2". Then she asked them to cover the hexagon with green pattern

blocks (small triangles). It took 6 of these. Barb asked, "If it takes 6 pieces to make the whole, what would I call this one?" (holding up one green block). There was no answer. Barb explained, "If it's one of six equal pieces, it's called one sixth." As the children removed each set of shapes, she asked them to line them up at the right of their worksheets. She asked them next to try the blue pieces (diamonds). It took 3. Barb began her usual question, "If this...," but Sylvia* said immediately, "One third."

Barb told the group to turn to the next page of the handout. There were two hexagons at the top of this page. First she asked them to show her by touching each group of shapes which were 1/2's, 1/3's, and 1/6's. Then she had them show her the fraction 2/3 in the left hexagon. She continued, "Now touch your 1/6's. Would you take 5 of these 1/6's and put them on the right? Ok so now you have 2/3 and 5/6." Ricardo* had put 6 green blocks down instead of 5, so Barb stopped for a minute to set him straight. She asked them which was more, 2/3 or 5/6? Jerry* said quickly, "5/6". She asked him how he knew that so quickly, and he said, "by counting them, 1-2-3-4-5." Barb said there was another way to prove it, by placing the 2/3 on top of the 5/6 to compare. They could see that 5/6 really was more. They cleared their worksheets. Next she asked them to find 1/2 and put it on the left side, and 1/6 on the right. She asked which was greater. Lana* said that 1/2 was greater because it "covered more." "So," Barb emphasized, "1/6 isn't bigger just because it has a bigger number." Similarly, Barb asked them to compare 1/3 to 1/2. Jerry* thought 1/3 was greater, but Barb showed him that 1/2 was actually greater by placing the two shapes together. She said, "Fractions are tricky. The numbers fool you. You have to think of pieces instead." Then they compared 2/6 and 1/2; again, Jerry* thought that the smaller fraction was really greater, until they compared the blocks.

The group had gathered an audience of Ernesto, Mario*, and Alonso*. When Barb asked them to compare 2/3 and 4/6 with the patter blocks, Ernesto interrupted to show that someone had only used 3/6. Barb asked him to please just watch. Raquel* showed that these fractions were the same because "the same amount was missing," i.e., the uncovered part of the two hexagons were the same. Lana* at first disagreed, but she had

> an extra 1/6 on her worksheet. Raquel* lined her shapes up on top of each other to prove that she was right. Ricardo*, at Barb's far right, did not seem to be entirely tuned in to all this. He was moving his set of pattern blocks around intently, lying on his stomach with the blocks about an inch from his nose. (I, pp. 13-14)

MATHEMATICS GAMES USED IN GUIDED INSTRUCTION. In a recent study by the Center for the Study of Evaluation, Baker et al. (1981) found the use of games and other adjuncts in instruction negatively associated with achievement. Baker et al. (1981) suggested that there was a need for process data regarding how games were actually used in classrooms.

> Questions may be raised regarding how teachers see the use of games, puzzles, and other adjuncts in their classrooms. Are they used to provide a congenial vehicle for rehearsal of learned skills? Is their use a planned part of an instructional design? Are they available to the learners to select, either as a form of practice, an exploration of a new skill, or as an incentive? Very little evidence is available bearing on these concerns.

In this study, children were observed playing mathematical games as a regular part of the instructional program in six of the research classrooms. Games served primarily as a way for students to practice/apply the basic facts, although some games, e.g. fraction games using Pattern Blocks and some counting games, requiring trading, were used also to develop concepts. Also, games provided a context for teachers and aides to provide assistance to students in learning skills and/or concepts.

Games and activities comprised the entire mathematics program during the observation period in two classrooms (B, H). Mathematics and especially 'gamemanship' were taught through games as well as reinforced or applied in game playing. Teachers, aides and others were observed providing instruction, clarification and management for the games.

In the following excerpt, a third grade teacher is using a game format to teach children the written symbolization for the 'doubles' multiplication facts. With the teacher monitoring the game, low achieving students had the advantage of finding out immediately if their answer was correct.

> The Shake-a-Score game required a written answer. Instructions to games were given in Spanish and English and children were observed talking in Spanish and laughing when playing the games.

> Sitting near the front door, I watched Shake-a-Score. All students had a paper with space for writing in the number rolled x 2 = and the answer. The students' sheet had eight spaces.
>
> Name ____________________
>
> 5 x 2 = 10
>
> 7 x 2 = 14
>
> x 2 =
>
> x 2 =
>
> x 2 =
>
> Score __________
>
> The dice were rolled and the number shown was the number written on the paper. It was multiplied by 2 and an answer was written. At the end of eight rolls, the answers were added together for a score. The person with the highest score was the winner and received a big heart sticker on his paper by Mrs. Brown. The group was reminded over and over again by Mrs. Brown to not help each other and not to say the answer out loud. Tim* rolled a double 6 and was surprised. He was able to get 24 for his answer by counting by twos. . . .
>
> . . .At Shake-a-Score, Ron won with a score of 272. Mrs. Brown added everyone's score and was surprised at his high score. A big heart sticker was placed on his paper while small heart stickers were placed on the others.
>
> At 1:15 the groups rotated quickly and quietly.
>
> Ed was excited as he left Shake-a-Score saying, "oh boy! Now I can play this at home now."
> (H, p. 12-13)

Management of games appeared to be an important factor in the successful use of games in the classroom. In the following example, protocols from several days' observations, suggested that a great deal of guidance was required from Mrs. Gray, the project assistant, during the time children were learning to play the

Grudge Game. The first example is of a group of mostly average achievers and the second excerpt is of a group of mostly lower-achievers.

> Mrs. Gray (PA) passed out the grudge cards and had the students lay their cards down on the table to make a family. I was sitting in the desk aside of the back table and back door. The PA walked around the table and checked each student's cards for pairs and families. She then asked each person to pick up their cards and hold them like a regular deck of cards. Mrs. Gray asked the group to pick a card they didn't want and place it face down on the table. Then she told them to pass it to their left. Don* was the only one to pass his card to the right. At 1:07 they were asked to do this again and passed. Ken wanted to know if he could put part of his family down on the table. Mrs. Gray said, "no, as the group will not pass the right card to you." At 1:11 Ken had dropped his cards and didn't pass a card. Mrs. Gray asked, "what happened?" Ken had a family of twos and was trying to put it down on the table when all of his cards fell out of his hands. In spite of this, he was able to grab a grudge while everyone laughed. He had 2 x 1, 1 x 2, and 2. In the laughter, the rest of the group forgot to grab a grudge. Mrs. Gray (PA) said, "didn't you notice something?" Then it was a mad dash to grab a grudge except for Beth and Diane who did not understand the directions. Lupita yelled, "grab one, Beth! Grab one, Beth!" Beth grabbed the grudge ahead of Diane although they reached at the same time. . . (H, pp. 8-9)

(A few days later: The Snowball group, the group having the largest number of Title I target students (7), required a lot of teacher guidance from the PA in learning to play Grudge.)

> At 1:13 I joined Mrs. Gray's group. Scott* was making a grudge (pipe cleaner) into a snake while Mrs. Gray (PA) explained the rules of Grudge. The pipe cleaner grudges were different colors--yellow, green, blue, orange and black.
>
> Boyd* said he had a family when he didn't. When Mrs. Gray checked his cards she said, "there was a little bit of a mistake." The group was having a problem listening as they were distracted by the grudges. The group was having fun making all sorts of shapes. However, Mrs. Gray placed all the

> grudges in the middle of the table and asked everyone to choose a card not wanted and pass that card. Everyone was now back into the game. At 1:21 everyone was asked to count their cards as Mrs. Gray was not sure everyone was passing an unwanted card. She was right and collected all the cards and reshuffled. The group was disappointed as many were close to making families. Boyd* made the comment, "when are we finishing?" as the cards were passed out once again.
>
> Later the group was back to playing the game of Grudge. Greg made the comment, "this is confusing." The group, including Greg, continued to play.
>
> At 1:23 two buzzers were heard in the room, but no response was made. The Snowballs laid their cards down again to see if a family could be had. No one had a family at this point. At 1:25 they were asked to place cards in their hands. Once again directions were given about taking a card that the player didn't want and placing it in front of them so they were ready for passing. This time everyone passed and several rounds were played. . .
>
> . . .Greg found it difficult to find families. His idea of family was 1 x 2, 2 x 1, but had trouble understanding an answer was needed to complete his family.
>
> Boyd* had a family and quietly took a grudge from the middle of the table. Everyone in the Snowball group managed to grab a grudge except David*. David* placed his Grudge down in front of him on the table. . .
>
> . . .Scott* had two possible families developing from the cards passed out. He was trying not to show his excitement. . .(H, pp. 10-11)

There were times when a child assumed the role of managing a game in the teachers' absence. The following excerpts show first a third grade teacher playing the board game Obey the Signs with children followed by a child managing the game activity, including engaging in Spanish discourse with a monolingual child.

> Mrs. Brown sat at the head of the instruction table in front of her desk and played Obey the Signs. She had made the game on butcher paper and modified the facts for this lesson. The students rolled the

> dice to see who received the highest roll to go first. A fact was chosen from the fact box (zeros, ones and twos) and then read by the student aloud along with his answer. If the correct answer was given, the student rolled the dice to see how many spaces his pond should be moved. Certain squares asked you to move ahead or backwards or to move to certain places. . . .
>
> The next day, Mrs. Brown was called from the room and left the game in charge of a female student, who filled the role very well and was accepted by her peers. In directing the playing of the game for a Spanish monolingual child, Vickie, the child always waited until the teacher had always switched to Spanish to explain the play. The child group leader also did this code switching as did the other children in the group. All discourse was in English except when directed towards Vickie. Earlier the aide had been instructing Vickie in Spanish. (H, p. 9)

Students need to learn the art of gamemanship if they are to successfully participate as a game player. In teaching the game of 'Old Strawberry,' the Mathematics Project Specialist also taught students the skill of keeping a poker face.

> It was obvious to me that Linda had "Old Strawberry" as she curved her cards for Ruth. Ruth did not choose "Old Strawberry."
>
> When Mrs. See (MPS) realized it had gone this way for the third round, she had Ruth return the card while Rose chose from Rick.
>
> MPS: "Suppose I saw "Old Strawberry" in my hand, what should you do?"
> Ron: "Pretend you didn't see it."
> MPS: "That's right."
>
> The MPS stopped a few minutes thereafter and explained they had to stop for today but could continue the game another time. The MPS took cards from Linda and demonstrated how the "Old Strawberry" was to have kept moving so no one knew you had it. Then she held the "Old Strawberry" card slightly above the others and asked the group if they would choose the "Old Strawberry." The group answered, "no." The MPS complimented Linda on the good job of hiding "Old Strawberry" throughout the game. . . (H, p. 20)

In a grade two classroom, a counting activity, as well as game groups required a great deal of assistance by both teacher and aide:

> The buzzer rang at 12:15 and students went to their math groups. Kathy's group was playing Spin A Flat at the game table. They were throwing the two dice and making or building that number on their computer card. The person with the most at the end of math time was the winner. Toi's group was counting using My Computer card, adding tape, Ten Blocks and pencil showing place value. At 12:21 Mrs. Bell passed out paper with squares that the students had been working on. They were using three egg cartons with ten pockets, toothpicks, rubber bands, pencil and their grid paper. At 12:25 Mrs. Bell helped Tim--he had one toothpick (unit) in each pocket of egg carton and needed to bundle this ten toothpicks to put in the ten's carton. He had trouble with the rubber band. Mrs. Bell asked Greg what he was doing with his toothpicks. He now had his last set of tens to another 100 giving him 300. He was using a grid with small squares. At 12:28 Mrs. Bell says, "When Greg reaches 1000 we are going to have a party!" Ted asks excitedly, "are we really going to have a party?" Mrs. Bell, "yes.". . .At 12:30 Mrs. Bell got up from her instruction table to quiet down the game table. The students wanted to go to 200 or more using three dice and flats. Mrs. Bell said she would like them to play for one flat (100). Now at the instruction table, the students did have a difficult time using the regular size rubber bands. Mrs. Bell was back to the instructional table where students were busy and excited. At 12:33 Mrs. Bell, from her chair said, "much nicer boys and girls." Then they explained what they were doing and Mrs. Bell approved. The aide was helping Bob count in Spanish. He was doing the computer game. The aide was moving from the game table to the counting table and back again. This way she could help Bob and also assist the place value concept at the counting table. . . .(B, pp. 9-10)

In classroom E, a Grade 5 classroom consisting of students from a range of ethnic and achievement levels, math games were a part of the fractions unit. The teacher, Mrs. R., usually moved from group to group during the activities period, quickly answering any questions that came up during the game playing. The game rules were somewhat modified by the children in that when they played Roll and Remove they put fractional pieces on their square rather than removing fractional pieces. The math content of the game remained the same but perhaps it was psychologically easier for the children to add rather than remove pieces. The game technique was also a way for a monolingual Spanish-speaking child to participate.

> An example of students modifying the rules of the game.
>
> The game the students are playing, Roll and Remove, was taught in last Thursday's workshop. But this group is playing a new version. They roll the die to put fractional pieces on their game square. A player continues to roll until he/she cannot put an indicated piece on the board, then passes the die to the right. Students are to say outloud what they rolled. And they are not to help each other.
>
> James is the first to cover his game board. Kim records his winning. No one comments on the winning other than to say he won. The boards are cleared and a new game starts.
>
> I move to the group by the front blackboard. In this group are Brenda, Alice, Gerald, Pete, Jake, Will and Linda. Linda does not speak English. She marks her pieces so that others check her, and she will know the pieces without speaking.
>
> Steve comes in from LD and joins the group.
>
> A cheater is called in the group by the west blackboard. This group stops their play to listen.
>
> Ms. W. asks Peg to explain what happened. Then Troy (the one accused) explains.
>
> Our group resumes its play. Soon Linda wins. She doesn't say so, but motions her win. A new game begins. . . .(E, p. 3)

Later in classroom E the students learned a similar game, Fractional-Coverup, which was played with rods. Students were intent on seeing that others obeyed the rules and played fair. Supervision in the game playing was provided by both teacher and aide. The next day the children's version of Roll and Remove, e.g. Roll and Add, was again played. The following protocol discussed the difference between a math error and a strategic error and describes how the teacher attempted to have students monitor each other's move. It also shows how games can encourage student's creative thinking and problem solving.

Math Error vs. Strategic Error. The students had arranged their desks in a tight fitting arrangement in order to play the game. This seemed comfortable and satisfactory to the children. This was a mixed ethnic group of Anglo and Mexican-American children and one black male child. The materials for the game were a wooden die with fractions on the die written lightly in pencil (1/2, 1/4, 1/8, 1/16, etc). It was hard to discover the fractional part from any child's throw because of the lightness of the pencil figure. Each child had a red square of paper representing one whole and strips of paper which were color coded blue 1/2; orange 1/8; purple 1/4; yellow 1/16. In playing the game, the students appeared to be interested and involved and while "winning" was important to them, they seemed to accept it when someone else won and were eager to play it again to try and win. In round one the object of the game was to cover the whole red sheet as fast as possible with fractional parts, each child having one turn at a time. Larger fractions were therefore desirable. Because of the lightness of the written fractions on the die it was hard for the children to monitor the occruance of each other's moves. In observering these games it is always of interest to note the number and possible reason for observed errors. In this game I observed only one error, that of a black male student, Carlos, who placed a 1/4 piece of paper down for a 1/8 throw, an error to his advantage in winning the game which went unnoticed by the others. The teacher at this time was with another group but seen afterwords gave general instructions to the class that they should be checking the accruacy of each other's moves and later gave explicit instructions to this group. The same child noted above played the same 1/8 through correctly later in the game suggesting that his first error had not been a math error but a strategic error.

The teacher mentioned that one reason she needed to keep in touch with how the children were playing the math games was that often they invented their own rules. She felt that the children's version of the game was usually as good as the original game and had the benefits of being understood by them--if the children didn't understand it on their own they couldn't play it. . .

> Mathematics Problem Solving Through Games. In the board group, after several rounds with different children "winning," the children began discussing fraction 1/32 and how one could make it out of the 1/16 piece by folding. They were also discussing whether a person would lose their turn if one ran out of pieces. From this they began to think about making more small fractions out of larger fractions by folding the paper. All seemed interested and involved in the conversation. This peer group discourse was continued when the teacher joined the group. Dee Dee demonstrated for the teacher the folding of blue (1/2) to make two 1/4 pieces. Debbie said, "If you get 2/16 (in the roll of the die) you just fold 1/8 in half and fold it up and open it up (to use it)." At 1:45 the children were not playing the game but discussing the folding and what fractions would result in a way that indicated understanding of proportion. . .(E, pp.4-5)

PEER MANAGED MATHEMATICS GAMES. A primary focus of this study, one that developed as we observed different classroom instructional situations, was the difference in the interaction of students in the various kinds of groups. In classroom C especially, where only Mrs. Smith, the teacher was present on most days, there was a marked difference between groups that were adult directed and game groups that were managed by the peer group. For instance, when a volunteer father was present in the Grade 2/3 room, he took charge of the game.

> Mike*'s group had a brand new game. He had four in his group. Mrs. Smith showed cards with instructions and was called One Up. The person who started had to have a red 1 and the next card should be a red 2 or they must pass. You took turns around the circle of four students and the leader. Only one card each turn and when all cards were gone that person was the winner. Mr. B dealt and took charge of this group. . . .(C, p. 1)

In contrast, the next day students were playing peer managed game during which competition and conflict emerged in classroom C.

> Mike*'s group was playing Two Up. Two Up was a card game in which you move by twos instead of ones (2, 4, 6. . .30). At 1:55 this group was enjoying the cards. These pink cards were handed out at Tuesday's workshop and Mrs. Smith made Two Up. Mike* was very proud that he had 14 as his first play in the game. Carol liked to tell

> everyone in her group how to count by twos and also which direction the game should be going in order to keep the game moving. Carol told the group that they should be moving clockwise so everyone had a turn. Mary* loudly said, "waiting for a 6," as she wanted the person with the 6 to play next so little time was lost in between plays. Helen* said, "come on," to Carol. Helen* asked, "you pass?" "No," Carol answers and plays her card. Mary* put the cover card down for her turn and laughed. Now Mary* and Carol had the giggles. Mike* wanted to know if they were playing for pennies or something. At 1:03 Mary* had the red 20 which was badly needed for the other students to play. Carol loudly asked, "who has the red 20?" After a second time Carol asked, Mary* finally put it down. Mary* said, as the game was ending, "I had number 30, Toilet Face," and laughs. Mike* said, "I don't want to play around." Carol sang a song in a low, deep voice. Another girl, Alice*, joined this group on the tan rug. She began by holding her nose and talking in a singing-type voice. Mary* shouts, "pass." Mike* was nudged by Helen* to play, which he did. At 1:03 Mary* won and Mike* acted like he was crying while lying on his stomach on the rug. Helen* said she didn't want to play. (C, p. 11)

On the following day, a pattern emerged which suggested that the game activity could not hold the students' interest for the period of time required for the other groups, i.e., the teacher-guided instructional group and the independent group, to complete their activities. In other words, children had only a short-term interest in the game and after playing it through once began to focus on the interpersonal dynamics of the group situation.

> Larry*'s group was on the rug to play Two Up. This game was played like One Up but you counted by twos instead of ones. . . .
>
> . . .Mrs. Smith reminded the Two Up group that yesterday's group was pretty noisy and could they be a little more quiet today. There were four in this group. Today the directions were written on the Two Up cover card (pink with green ink). At 12:27 Sally* wanted everyone to count their cards and everyone did. . . .
>
> . . .12:45. Ann* and Alice* came to Mrs. Smith as Ann* told on Alice* for calling Sally* names

> and also saying bad words, while Alice* denied this. Alice* almost tore a playing card as well, according to Ann*. Alice* was asked to put her head down at a table which she did. . . .(C, p. 12)

A protocol from the next week in the same classroom, (C), tended to substantiate the hypothesis that the game activity did not hold the interest of second and third grade students for a half hour without a directing adult presence. This appeared to be due as much to the social demands of the game activity--demands of conflict resolution, abiding by rules, fair treatment of others, negotiating first turn, etc., as it was from any mathematics/cognitive demands placed upon the students.

The following excerpt shows increasing intragroup conflict as the game progresses and its easy resolution by the classroom teacher when the group rotated to the instructional table. It should be noted that this kind of conflict was observed in fifth grade groups, e.g., Study E, but more quickly resolved, suggesting that younger children have not yet developed the personality skills to readily handle the competitive situation of the games on a peer-managed basis. Also, as suggested in Study H, E and B protocols, children often benefited from adult assistance (supplied by aides, volunteers, teacher and resource teachers) within the process of using games for learning concepts or skills not yet completely mastered.

> The Game Group. These observations were focused on a third group, the "game" group of six children who were sitting behind the room-divider shelf on the rug. The observer sat on the side table which was not being used by students and which permitted a good view of the whole room. The teacher explained the game of Zooks to the group of children on the rug. The teacher, sitting (or kneeling) on the rug, showed the children a pack of cards and said, "these cards have numbers on them, if you see any two that add up ten you say Zooks and you get the cards and set them aside. Play the game through." The teacher then went over to the opposite end of the room to the guided instruction table, and the children began to organize themselves for playing the game. One child, Rita, assumed the role of dealer and informal leader of the group. She began acting out by talking loudly and clowning, saying such things as, "I don't know why I deal out all those cards." Another child said shussh to her, and there is a general group discussion about how many cards did each one get. Then the children discussed the direction of turn taking, using gestures to indicate clockwise or counterclockwise.

Rita finally said, "okay go," and the children started playing, with the exception of one child who laid down. All tend to call Zooks at once and there is much discussion about who really said Zooks first (thus winning) and if the numbers really add to ten (sometimes the group detected math errors, sometimes not). Opal defended her claim by saying that there were two cards with 2 and one of 6 so she should get everyone's cards at that turn. The children allow this (perhaps not remembering the directions of using only two cards or else perferring their own rules). As the children take turns, more heated argument continues about who wins until finally Opal said, "all right, you cheat, I'm not playing."

. . .At 1:35 the children have finished playing the game, Zooks. Rita says, "Lets go tell the teacher we played it." Others say "no." Doug says, "Yes, its boring." While Rita counts out the cards to see who won, Doug walks over to the teacher, addressing her by first name as is the custom syaing, "I think its boring...everyone's stopping the game....Opal left the group and won't play with us."

(It should be noted that ordinarily the teacher could not hear what children are saying, nor see what they are doing in the game group on the rug; in addition, the teacher was occupied in presenting the math lesson to another group at this time.) The teacher told the children they might choose another game but that it must be mathematics. In the group, John and Roger begin to play "2 up" as a dyad. Another pair, Rita and Doug began to organize to play "1 up." Jack and another boy want to join and, sitting next to Rita and Doug start kicking each other playfully on the bottoms of their feet and wrestling, disrupting the dyad attempting to play the game. (The conflict between Jack and the others continued until the teacher removed him from the group.) (C, pp. 13-14)

The Teacher-Guided Instructional Group. Groups have rotated with worksheet group (Group 3) on rug for game playing and game playing group (Group 1) with teacher at instructional table. (Group 2 doing worksheets)

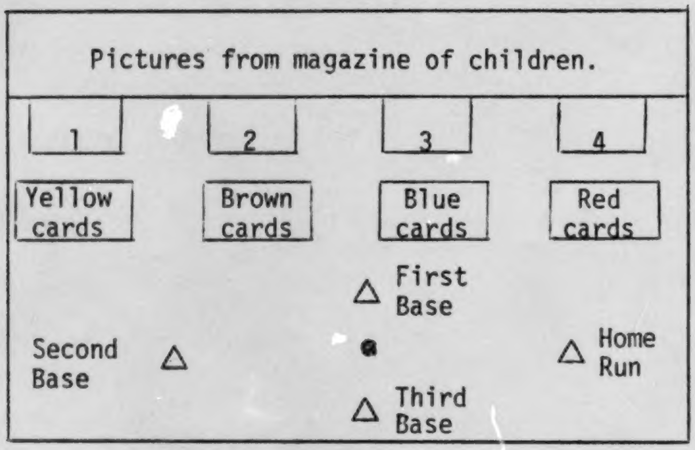
Group 3, while playing Zooks, including the one black girl formerly rejected, notices Jack out in

> the hall. One of the children says, "Jack got a whipping." 1:54 Teacher goes out to the hall to bring Jack back to the instructional table (while the rest of his group are remarking to each other how Jack deserved the punishment).
>
> The teacher immediately got Jack involved in the lesson by sitting him next to Roger and having them work out an adding exercise in which Jack has longs and units comprising 36 and Roger has longs and units comprising 27 and together they exchange units of 10 or more for longs to work out the answer. The teacher during this process, reprimands Rita for acting out, saying, "Rita, would you like to go out to the hall?" Rita sits up. (C, p. 14)

Several weeks later, Mrs. Smith taught a new game, Batter Up, a subtraction game, to a small group of children. The children appeared to learn the game rules easily enough but not all of them knew their subtraction facts well enough to play the game.

Mrs. Smith had been expecting the help of a father volunteer and possibly that of the resource teacher but neither showed up. The protocol indicates that the children stayed on task for the first round of the game, which took 15 minutes, but that after that disruptive, off-task behavior by one child in the group, Larry*, a target child, and by two boys who were then assigned to the independent worksheet group, was a constant factor on the rug when the game playing was taking place. These two children, Chuck and Ken*, apparently would have liked to join the game but as they weren't in the group instead played for the attention of group members in other ways. However, the game went on as if the children barely noticed Chuck's disruptive behavior. The excerpts from the protocol show how the game was set up and played through the first round and also includes an episode towards the end of the game where children disagree about the right answer.

> First Round of the Game. Mrs. Smith explained that the questions to this game were subtraction, sorted into levels of hardness. First Base questions were easy and the hardest questions were Home Runs. The game board looked like this:



One team played at a time. Sally* was asked by Mrs. Smith to be responsible for the rubber bands which went around the cards. The die had 1 2 3 HR SO (Strike Out) and W (Walk) on it. The object was to throw the die and look at what was thrown and then a card was chosen from under the proper space and answered before the student moved his disk. Example: a 2 was thrown. A 2 or brown card was taken, 10 - 5, and answer of 5 was given. Then the student's disk would have moved 2 squares, which would have put him on second base. A score was kept on the blackboard for each team. At 12:24 this group (Larry*, Alex, Ann*, Sue, Alice* and Sally*) was left to play Batter Up while Mrs. Smith returned to the back table. At 12:25, Mrs. Smith returned to the game group where Larry* had just turned a HR on the die. The red card had the equation of 14 - 5, which was answered with a 9 and he* got his home run. After Larry*, came Ann* stated, "we don't need any help. We can do this by ourselves." Sally* and Sue were playing on the red team. By 12:28 Alex and joined the group and Mrs. Smith left to instruct the back table. As the teacher was leaving, "miss a question or throw a strike out, the other team plays." Alex had his turn as part of the blue team. He had the question, 15 - 9, which he couldn't answer. Sally* gave the answer 6 and blue was cleared off the board. Larry* had put 2 on the board for Team Blue's score. Larry* and Ann* had run off to tell Mrs. Smith of their game and score to be sure they were correct. (There might have been three strikes, like real baseball, that had confused them.

> End of the Game. Everyone at the game laughed when Ann* and Sally* struck out. The score was 4 Blue, 2 Red. Sally* played with crossed fingers on both hands. Chuck had shocked Larry* again. Ann* reminded Larry*, "remember, Larry*, Chuck is your friend." "Not anymore," as he* walked over to Chuck with fight in his eyes. Mrs. Smith, "Chuck and Ken*, settle at a table." They settled at the table in the corner behind me where the orange beanbag was located. Sue had been counting on her fingers to arrive at the answers for 13 - 8. Counted, "12 11 10 9 8," answered "5." Larry* helped her count 12 11 10 9 8 and stopped. Sue cried because Sally* had said Sue was wrong as the answer should have been 6. Sue insisted the answer was 5. Sally* insisted the answer was 6. Sue got up from the group and went near the door while Ann* and Sally* had started to put the game away. I had asked, "why are you putting the game away?" "Because Sue is crying over her wrong answer." Ann* said, "Lord, Jesus Christ." (C, pp. 19-21)

The following excerpt from the protocol shows children playing the Zooks game by their own rules, which were different from that of the teacher's rules, as the ethnographer's note indicates. Ken* appeared to be learning the rules of gamemanship.

> Zooks. Opal passed out the cards to each person in the group. (The group at table): Chuck, Ken*, Rita, Opal, Lee and Toby (absent). Lee asked how the game was played. Opal: "If you want to know then read the card." Ken* was to be third. Ken* was upset! After the first round, the group had to show Ken* how to show his card away from him. Opal said, "Zooks!" with only a count of 8 and started to clear all the cards off the rug. Rita counted before Opal took the cards off the rug. Rita counted before Opal took the cards and proved the sum was 8. Ken* said, "Zooks," first but wasn't chosen as first one saying Zooks. He then claimed he wasn't going to play. Rita reminded him, "you will have to play after school." From then on to be sure he is first, he yelled, "Zooks," for every play. Even with this system the group, mainly Rita, declared other players as winners. With what I thought would be the last two plays, Ken* got the cards for Zooks. He* and Opal tied for the last play. Rita handed Opal two cards and Ken* two cards for that hand. However, Ken* said, "Opal said it first." He* handed her his two cards which she accepted. At

> 1:03 Rita counted her cards. Somehow with her five cards left, she managed to go out the next round. Rita along with the other students, took the cards they had collected from Zooks and placed them in their hands to continue playing the game of Zooks. . .
>
> Ethnographic Assistant's Note. Rule Four of Zooks stated: "When all cards have been turned up, the player with the most cards wins." However, the group played the game like "War," where the cards were turned over and over again until only one person had any cards left. I have not seen either teacher play any of the games all the way through, so I am not sure if the students really know how to play the games from beginning to end. . .(C, pp. 21-22)

The excerpt from a later protocol indicated that the "game" group was more easily managed when students were free to move to another activity after a few rounds when their natural interest in the game began to diminish.

> The Game Group. In Mike*'s group, Ginger had returned after two weeks of pneumonia. Each person was dealt his cards. Helen* and Carol had tied for the first Zooks which Mike* had declared Carol as the winner. It was also agreed by Helen*. The next round had also ended in a tie again with Helen* and Carol. Carol was declared the winner again by Mike*. The next round had ended in a tie between Helen* and Mike*. Carol had declared Mike* the winner. (The game had ended by my standards as Mike* ran out of cards and would have to turn his Zooks winnings over in order to continue playing.) Mike* had run out of cards and Helen* said Mike* had to use his cards to have completed the game. Carol did not agree with Helen*, however, she gave in. The game had ended at 12:37 as Mike* only had enough cards for several rounds and Ginger had run out of the cards as well. Carol had the most cards and was declared the winner. It was 12:38. Shortly afterwords Carol and Helen* played Two Up and Mike* and Ginger went over to the free choice table. (C, pp. 22-23)

In the followup study in classroom C the next spring, games were still a major part of the instructional program but towards the end of the observation period were not used as a required activity for the entire time that another group was working independently or with the teacher. More emphasis was placed upon using the games in direct instruction, followed by worksheets and free game playing on a choice basis. This seemed to be successful in reducing some of the acting out during unsupervised game playing. Conflict over such things as who should go first, and disagreement over rules was still a problem. Mrs. Smith planned to remove games as a center next year if she remained without an aide. Instead she would have two larger teaching groups for four days a week and one day for games which she would supervise. She felt games were a very important tool for learning math but that they required supervision.

In research site F, Mrs. Jones, the Mathematics Project Specialist, introduced the game format for direct instructional purposes, with the game "Roll- and-Remove." The preparation of the individual game "boards" and "pieces" had taken quite a while; one group never did get to the playing stage that day. The routine of "trading" in the game had the most relevance to the week's fraction lessons, as it indicated a real understanding of the comparative values of fractions (e.g. two 1/4's could be traded for 1/2).

> Louisa rolled 1/4 and had to figure out that she could remove 4 1/16's. It was back to Gordon. He had 1/2 and 2 1/16's on his board. When he rolled 1/4, he had to trade his 1/2 in for 2 1/4's. The trading was the most important part of the game, because it demonstrated the ability to think in terms of fraction equivalencies. Ben* was singing a song about "Gimme gimme something good to eat," dancing in his seat. When he rolled 1/8, he said, "I don't have one." Louisa said, "Yes, you do. The orange one." Mrs. Jones asked him to please sing later, but he continued. The game was picking up pace as one child after another figured out the trading routine. When it got back around to Ben*, Mrs. Jones showed him how he could trade 1/4 for 2 1/8's. Mrs. Jones asked, "Do you see why the other children have been trading for just one?" (i.e., putting 1/4 back and only getting one 1/8 in return, since one would be removed, anyhow.) One child explained that you "put two on and take one off." (F, p. 13)

The game format generated excitement. Unlike the MPS's other methodical, step-by-step presentations, it was unpredictable. And there was a chance to employ strategy to "win."

> Ben* rolled 1/8; he had a 1/2 left on his board. The rest of the group gave him suggestions on how to do this one. Angela said, "He needs four,

> Miss." Louisa said, "No, take three. You put one back." Angela rolled 1/8 and passed the dice. She had 3 1/16's on her board. Miguel* said, "You could! You could!" Ben had 1/8 left. He rolled 1/16, but passed the dice. Mrs. Jones asked him why. He said it would be easier to get 1/8 than 1/16. (Strategy) He rolled 1/16 on his next two turns. Mrs. Jones was chuckling softly. Ben* decided to remove 1/16 this second time. On his very next turn he rolled 1/8, and moaned "Oooh." Mrs. Jones said it was time to pack up the games. (F, pp. 13-14)

After the mathematics project specialist had left the classroom, the teacher, Mrs. Franklin, continued using games as part of the instruction in the unit on fractions. The following protocol indicates the dependence of students who have not yet fully mastered the concepts on teacher assistance. (In contrast, a later protocol, F, p. 16, not included here, indicated that higher achieving students caught onto the game more quickly and were able to sustain the game on their own fairly well.

> Teacher Directed Game. As it turned out, Mrs. Franklin would be plagued by the same "timing" difficulty that had bothered Mrs. Jones the week before. The independent group was finishing their worksheets, while Mrs. Franklin had barely had a chance to deal out the cards for the game: One (or I Can't Believe I Made the Whole Thing.) Angela had finished first and was standing by Mrs. Franklin's elbow wanting to know what to do next. She told Angela to do her spelling or read a story. Back to the game: the children did not seem to be seeing which fraction cards they could add together to make "one." Mrs. Franklin had to coach each one through his/her turn. She asked them to get their Roll and Remove games out of their cubbies. She showed them that they could, by placing various squares and rectangles on the big square, see that 1/2 + 1/2 = 1, or 1/4 + 1/4 + 1/4 + 1/4 = 1. "How many make a whole?", she would ask. "Eight of those, Miss, " answered Tommy*, and "Sixteen of these," answered Roberto*, thinking ahead. She asked the children to look at their cards to see if they had any "Wholes." Roberto*: "I've got 6/8, Miss." "Then how many more do you need?" "2" Mark* came up to show Mrs. Franklin that he had finished his worksheet. (F, pp. 14-15)

Once she felt her instructional group had grasped the game, Mrs. Franklin left them on their own. But without her guidance the game deteriorated.

> Peer Directed Game. Roberto* and Tommy* got deeply involved in a discussion about Tommy*'s cards. He didn't have exactly the right fraction to make a whole--what should he do? Roberto* said, "So start over." The game was getting lost. Tommy* left shortly to draw cars with Miguel*. Roberto* was very concerned with the dealing role; he was shuffling the deck a lot, not really attending to the players. But Margaret and Shanti continued with their own process: Margaret would read the fractions on the cards to Shanti, who selected the corresponding shapes to place on her board; Margaret was asking "Dit it cover the whole square?" Margaret also followed Mrs. Franklin's pattern of laying the playing cards on top of the shapes. Sylvia* and Anita were using the same pattern, speaking in Spanish. Margaret read the fraction "2/4" to Shanti, who chose 2 1/8 squares to lay on her board. Margaret said "No," and removed them herself. "I said 2/4. Two of them." When Mrs. Franklin came by to see how they were doing, Roberto* looked up at her and said, "I already know how to play this game, Miss." But the logic of the "game" was gone, in that it was no longer a group effort, but partners working together with Roberto* supplying the cards as needed. (F, p. 15)

An observation of student game playing two days later indicated that most of the low achievers had begun to master the concept of combining unlike fractions to make a whole. Teacher guidance remained important but a few students were beginning to manage the game on their own.

> Today's structured group consisted of Jo Ellen* (who missed all the math sessions last week), Frankie, Marta*, Angela, Mark*, and Roger. Mrs. Franklin was using a combination of the One card game and Roll and Remove again. Mark* (who had played before) soon lined up his cards and shapes and saw that he had only 1/8 to go to make a whole. Frankie, too, was wanting one more card, while Marta* and Rogert, new to this game, were still looking over their cards and shapes. Jo Ellen* had cards of all three denominators 1/2's , 1/4's, and 1/8's and looked confused about what to do with them. Angela joined Mark* and Frankie demanding another card from Mrs. Franklin, who said they

> would have to wait. She explained that they were going to have to take turns, with her checking over each player's hand to make sure they were getting the idea. She slowed down the pace, taking time to show everyone how Roger had 6/8, 3/8, and 4 1/8's. He could use his 6/8 and two of the 1/8's and keep the rest for his next turn. Mark* said, "Look, I could do it, Miss. 2/4 and 1/4 and then it takes 2/8 so I used all of them," as he lined up his shapes on the board. Mrs. Franklin introduced the idea of trading, showing Mark* how he could trade 1/4 for 2/8. Jo Ellen*, who had been absent all last week, was still moving her shapes around as if she were not sure what to do. She put her 2/8 card down with the 1/4 shape after watching Mark*'s turn, showing that she understood this equivalency. Then she added another 1/8 but this left her with a 7/8--too much, and 3/8-- not enough. Frankie showed her she could use just the 7/8 and the 1/8 to make a whole, but she looked puzzled. Mrs. Franklin said, "How could you do it?" She showed Jo Ellen* that if she used the 3/8 + 2/8 + 1/8, there was no room for the 7/8. Frankie broke in and repeated how Jo Ellen* could use the 7/8 and 1/8.
>
> . . .As soon as Mrs. Franklin left, Roger was besieged with request for cards. He had to give up his own game to attend to the other players. Mark* exclaimed, "I won!", but Roger showed him that he still needed 1/8--his cards were spread out to look like they covered the whole board, but when Roger shoved them over, there was space left. Jo Ellen* was playing with her shapes, stacking them up in neat piles. She had borrowed this fraction game from someone who had been present last week, so maybe she just wanted to make sure she hadn't lost anything. By 11:10 Angela was ready to give up on the fraction game, urging the other children, "Let's play Fish." Everyone started packing up their games and getting up from the table. (F, pp. 16-17)

Later the classroom teacher (F) gave the children a worksheet of fraction addition problems on 2/16, their first really abstract fraction task, after two weeks on this topic. They were allowed to use their fraction kits to work the problems. There were clear divergence between the performance of the target and nontarget children. Several of the target children had problems with adding fractions with unlike denominators, even though they seemed to have understood this in the game context.

As the fraction unit stretched into its third week Mrs. Franklin continued the game-worksheet format. She gradually included more abstract or number-only activities, while encouraging the children to use their fraction "Kits" for help. (The following excerpt shows children helping each other in this task.)

> Marta*, Mark*, and Sylvia* were working together on the blackboard problems. Marta* said aloud, "One whole equals how many 8's?" She lined up her 1/8 shapes on the "1" square, and saw the answer, "Eight! Eight!" Sylvia* and Mark* filled in the same answer on their papers. Ben*, working by himself near the blackboard, was not using his fraction kit, but seemed to be doing fine. Roberto*, sitting near him, was on the third problem (many of the other children were finished). He asked, "What are we supposed to do?" as he shuffled the shapes from his fraction kit and played with the dice from Roll and Remove. Back with Marta*, Mark*, and Sylvia*: Marta* was asking herself "Ten sixteenths equal how many eights?" She gathered up 10 of the small squares and started lining them up on her 1/2 shape. Then she stopped when this didn't seem to work. Mark* simply counted out 10 small 1/16 squares on the table, and counted them by 2's to get the correct number of 1/8's. "It's 5," he told Marta*. (F, p. 18)

TRANSLATION OF REPRESENTATIONAL MODELS TO WRITTEN OR PICTORIAL MODES. Recently, researchers have found the concept, zone of proximal development, useful for describing an optimal instructional situation where children can display competence, when assisted by adults or in collaboration with peers, that they would have been unable to do independently (Cazden, 1981, Quinsatt, 1980). In psychological assessment, the child is first asked to answer a question independently, and upon failing, his/her proximal development level is found by providing successive clues in a supportive social setting until a correct response is generated (Brown and French, 1979). Then, to test the child's conceptual understanding, s/he is asked to do a different version of the same task. The manipulative aids and games provided an opportunity for teachers and mathematics specialists to attempt to assist low achieving students to perform tasks using the aids that they would be unlikely to do independently as written tasks; however, the problem remained of helping students translate their understandings from the concrete to the written and pictorial modes.

One of the characteristics of children experiencing serious difficulty in school mathematics is a gap that may occur between their understanding on an informal level, e.g. the manipulative level, and analogous written procedures (Ginsberg, et al., 1981, p. 10). It is often difficult for a teacher to find the exact level of proximal development that students are at in the continuum between the concrete level and the written level. For instance, in Case Study E students had difficulty playing the fraction game of One when the cards had only the fractional numbers written on them but, later, after pictures of pattern blocks with fractional parts were added, they could play it easily.

> Overview. The game of One required students to understand how two or more, same or different, fractions added up to one whole using cards with fractional numbers written on them. The concept of adding fractions had not been addressed previously in classroom E, and proved to be difficult for the target students.
>
> Game of "One" With Written Fractions. P., the Mathematics Project Specialist, goes through the directions: each player will receive seven cards; the object is to make 1 whole. For example, 2/6 + 2/6 + 2/6 = 1 whole.
>
> Thomas* shuffles the cards and deals seven to each player.
>
> Will turns away from the table to sort his cards in his lap.
>
> P. tells the students to fix their cards so all 1/2's, 1/6's and 1/3's are together.
>
> Jake is first to start. P. helps him put 1/3 + 1/3 + 1/3 down to make 1 whole, and then tells him to draw.
>
> Next, P. helps Will with 1/3 + 2/3's. Will has difficulty comprehending discarding.
>
> Next, P. helps Roberto* who has several "wholes," but is not putting them down. P. writes the combinations on the board to illustrate and clarify the objective; 4/6 + 2/6; 1/3 + 2/3. Roberto* puts down his "wholes" and discards.
>
> P. helps Katerine*. A 2/3's is on the discard pile. She has a 1/3 and 2/6 card in her had. P. asks Katherine if she wants the 2/3's card or to draw. Katherine chooses the 2/3's card, but places it with her 2/6's card.

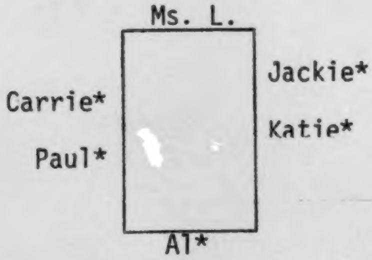
> Next is Don*. He too has trouble with 1/2 + 1/2 being a whole. . . .(E, p. 6)

The next day, a picture of the pattern block representing each fractional part was added to the symbolic representation of fractions on the cards in the game of One. With this "visual aid" children were more successful playing the game indicating a mastery of the concept of fractional parts equalling a whole on the representational level but not on the symbolic level.

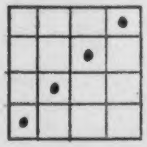
> "One" With Visual Aids. Katherine begins. She has one whole and sets it down: 2/6 + 2/6 + 1/6 + 1/6.
>
> As the game continues, the students show much more understanding of the game objectives. P. helps very little as compared to yesterday; at least one whole pattern was put down by each player without being told. . . .(E, p. 7)

Games designed for maintenance of skills or practice sometimes were difficult for low achievers who had not completely mastered their facts. The following excerpt indicated that some third grade low achievers who had mastered the facts at the manipulative level did not know their facts well enough to play the game of Bingo.

> Ms. L's new group included Carrie*, Paul, Al*, Katie*, and Jackie*.
>
> As the game began, Carrie* watched to see what Paul played and copied him. Jackie* looked at Katie*'s board and copied her.



> Al* was behind. He didn't comprehend the multiplication and answers quick enough to stay up with Ms. L.
>
> One time, for the answer "4," he put down "2 x 4," having noticed the four.
>
> He did manage to fill in four spaces diagonally.



> But when having read the problem aloud, he said 2 times 4 equals 8, instead of 2 x 2 = 4, so the piece was removed and the game resumed. . .
>
> 11:08 Al* and Katie* were playing on their own and getting bingos. Carrie* and Jackie* were still looking at other boards for help.
>
> Jackie* hadn't made a bingo yet. Even though Carrie* had, she didn't call one. . .
>
> I asked Ms. L if students ever asked her to say "Bingo" as she played a board also. She said she played a board to keep track of answers.
>
> Ms. L said she realized Carrie* made bingos by looking at other students board, therefore she did not call attention to it. (G, p. 8)

The translation process itself, even in the same mode, could cause difficulty in student learning as in the following example when the mathematics project specialist changed the fractional value assigned to pattern blocks. In this observation Barb, the Math Specialist, tried some new fraction addition techniques with five children during the hour spent in the classroom. She was following a book called "Fractions with Pattern Blocks." It was an experiment in getting the children to see that the pattern blocks could represent any fraction, i.e., green is not always 1/6. By using a bigger "whole," she changed green to 1/12. This activity was performed easily by the group. Then for the game at the end, she changed the values of the pattern blocks back to those of the previous day. The game was more difficult and required teacher assistance.

> Card Game. It was called "I Can't Believe I Made the Whole Thing," the same name as the game they had played Monday and Tuesday with pattern blocks, but this one was a card game. She told them that she had made this card game for their class. It was in a manila folder with the directions printed on the outside so they could play it again by themselves after she left. Each card was printed with a fraction and a picture of the fraction as it would look in pattern blocks with the yellow hexagon as "1."

> This meant they would have to shift back to thinking of red as 1/2, etc. The object was to collect fractions with the same denominator to make "wholes," which could then be "laid down" as in rummy. It also had a rummy-like draw-and-discard pattern. Each child got seven cards to start. It seemed to take the children a while to catch on, especially Juanita and Barbara*, who looked confused. Ricardo* lined up pattern blocks on his cards to "see" what he had. These three needed Barb's help to decide what to do with their hands. Ricardo* kept shuffling his cards and looking them over, but not indicating that he knew what he was looking for. Juanita tried to lay down 2 1/6 cards, but Barb explained that that did not make a whole thing. . . (I, p. 18)

In an example of third grade students doing a textbook activity based unit on mulitplication, at least part of their difficulty appeared to be in understanding the vocabulary and symbolism of the textbook.

> Ben* found the math pages "hard." The pages consisted of pictures where students made equations to fit the pictures. Other pages had equations like 1 x 1 = ____, ____ x 5 = 15, ____ x ____ = ____. Gary* was having the same problem trying to make the equation fit the pictures. However, the group found a column of facts "easy."
>
> Ben* accused Gary* of copying, which he was, and Gary* didn't deny him. Ben* understood facts as facts.
>
> Boyd* asked me what was this:
>
> The product is _______. There are _______ flowers.
>
> I explained to him that product was another word for answer. He was able to continue his work. . . .
>
> . . .Bonnie* was having trouble knowing whether the bees or flowers were first in her picture in the math book. ___ x 2 = 10. There were two flowers and five bees in each flower pictured in the book. . . . (H, pp. 21-22)

Often classroom teachers used materials at all three levels, concrete, representational and written levels. In this way, students were made aware of the written system and also learned to use the manipulatives as tools in finding the correct answer. In classroom C, the teacher followed this procedure for teaching 2 digit addition and in classroom G, the teacher followed this procedure in teaching multiplication and division. The Mathematics Project Specialists often taught recording as part of manipulative activities. This procedure may be only a partial solution to the translation problem however as classroom G students still did poorly on the textbook multiplication test. There may be a need to focus more specifically upon the steps in the translation process needed to be learned by low achievers and also a need for teachers to use tests in evaluation that more closely match the objectives of an activity based program.

Discussion

An ethnographic methodology was used in an attempt to generate hypotheses, and accommodate the research to natural classroom and program implementation processes. While a number of research questions served to focus observations, an attempt was made to produce protocols that were richly descriptive of the classroom structure and interactional processes as they happen. Therefore, results are not conclusive but rather suggestive of patterns or hypotheses generated by this method of research.

The observational data suggested that manipulative aids such as Cuisenaire rods and pattern blocks were very appropriate for the instruction/learning of the low-achieving student. Often low achievers were more successful doing manipulative activities than other math activities. However, in using manipulatives for instruction, students must first be taught the meaning and use of the technology of manipulatives. In a society such as ours, heavily dependent on computers and other forms of technology, learning to use several different representational systems may be useful in itself as well as for learning elementary arithmetic. The data provided numerous examples of teaching children the meaning of, and even how to construct, manipulative aids. Much guidance to individual students was observed in the use of this instructional strategy, and because of this, small-group instruction seemed more appropriate, especially for low-achieving students, than whole-group instruction.

In most classrooms students were observed playing mathematical games. However the role games played in instruction varied, as did student response to the games. Teachers seemed to view games as either a teaching strategy, i.e., games were used as a part of instruction and learning new concepts and facts, or for use as maintenance of skills already learned. Sometimes games were used as an independent small-group activity but this was difficult to manage without supervision of an aide or other adult in primary grades. Also groups of younger students, Grades 2-3, appeared to have difficulty in managing the competitive aspect of the games without supervision. Training in gamemanship appeared helpful and was sometimes provided by the resource teachers. Game playing of self-selected partners was more easily managed on an informal than an assigned group activity basis when adult supervision was unavailable.

Games appeared to be a potentially useful way to diagnose individual skill attainment and give individual assistance in skill and concept development to small groups of students. When observing games used as a teaching strategy, it was clear that individual low-achieving students benefited from adult help.

Commentary

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This study is extremely important in that it provides a rich description of elementary school mathematics classrooms over an extended period of time. This type of detailed description of the classroom setting for mathematics education has been sorely lacking. Suydam and Osborne (1977) in a review and analysis of pre-college mathematics education from 1955 to 1975 conclude that decision-making for educational policy is frequently ". . .determined without collecting enough information to allow the process to be rational (p. 21)." Some of the areas related to teaching mathematics that they conclude that we do not know enought about are: (1) the amount of time that teachers allocate to mathematics instruction and the manner in which this time is used; (2) the extent to which teachers differentiate instruction; (3) the extent and nature of teachers' use of manipulative materials; and (4) the identification of the factors that determine teacher's use of non-text learning materials. This study of nine classrooms provides data to begin to investigate these crucial issues.

This commentary will try to add another dimension to the interpretation presented in this report. It will analyze the organizational patterns described in the case studies and discuss the lack of any attempt to differentiate instruction. Some curriculum concerns will be raised in regard to the manipulative materials and games that are described in this report.

Organizational Patterns and Differentiating Instruction. In the nine classrooms observed, three different organizational patterns (with some variation) were observed in the first week's observations at each site. This was prior to a Mathematics Project

Specialist's (MPS) presence in each classroom. I have focused on these observations as they are probably more representative of what usually occurs in these classrooms. In some cases the organizational patterns changed when an MPS was in the classroom. The organizational patterns observed were: (1) whole-group instruction with "extra-help" for children having problems (F and I); (2) some type of small group instruction (B/C, D, E, G and H); and (3) individual contracts (A).

The small group organizational patterns were not chosen by the teachers so that they could vary instruction but to facilitate the use of manipulative materials and games. Even though it is encouraging that two-thirds of the teachers were using manipulative materials prior to the MPS's visit, it is disappointing that all of the groups in each classroom had the same instruction, used the same manipulative materials, and played the same games. This even occurred in the two classrooms (G and I) where it was apparent that the children were grouped based on their mathematics achievement. Yet from the excerpts from the protocols included in the case studies and in Part II of this report, it is apparent that some children were having more success than others in using the manipulative materials and in playing the games. At times, when new concepts and skills were introduced some children had mastered the necessary prerequisites and some had not. Yet instruction proceeded in the same way for all children. In most cases the activities and materials used were appropriate for teaching the objectives, however some children were not ready to be taught those objectives. This pattern of using the same concrete materials and games for all children in a classroom, but in small groups, also continued when the MPS taught in the classroom.

Despite the failure of both classroom teachers and MPS's to take advantage of the small groups to vary instruction, the principal investigator observes the following important advantage of small group instruction over whole-group instruction:

> Because the class had students with a wide range of achievement, instruction in small groups especially benefitted the lower achievers, who participated more actively in the smaller groups than in whole-group instruction. It was the higher achievers who verbally interacted the most with the teacher in the whole-group recitation organized instruction. It was our impression that the teacher-student discourse in whole-group instruction required the quick responses that higher achievers readily gave in order to maintain the pace of the lesson. (E, p. 5)

In classroom A children worked on individual contracts at their own pace. The teacher and aide spent the total mathematics period rushing from child to child trying to provide the help that the children were constantly requesting. The teacher appeared to be under stress while trying to respond to individual students. The students were focusing on getting answers so that they could complete their contracts. This one attempt to differentiate instruction did not seem to meet the needs of the children. These observations are related to Suydam and Osborne's (1977) conclusion that ". . .most low-ability pupils find it difficult to function using self-paced programs (p. 77)."

The "extra-help" sessions connected with the two classes engaged in whole-group instruction did not provide any differentiation of instruction. In the "extra-help" groups the teachers simply repeated explanations given earlier during the whole-group lessons. The strategy seemed to be to lead the students having trouble through the computational procedures--in one case, adding fractions with unlike denominators (I) and in the other case, doing long division (F)--until they could do it independently.

All of the teachers and MPS's in this study were aware that the children in these classes differed in mathematical knowledge and ability. It is obvious that the teachers tried to develop an organizational plan to help all of the children in their classroom learn mathematics. But they did not teach the children mathematics at their level of readiness. This would have required, at the very least, varying the pace of instruction, and hence the activities and the specific objective taught on any given day. Suydam and Osborne (1977) report that grouping for specific needs is an effective strategy for differentiating instruction, but that many teachers find it difficult to group for mathematics instruction. The teachers observed were making different degrees of progress in grouping for mathematics instruction. They now need to expand their notion of grouping to include grouping for specific needs.

The principal investigator's discussion in Part I of this report of the ambiguity surrounding the MPS's role explains the reason why the MPS's did not group the children based on their mathematical achievement when they were teaching the classroom. I think that the MPS's could have discussed this need to vary instruction, with those teachers who had experience with small group instruction, at the planning meeting prior to the MPS's teaching in the classroom. Their failure to do so may represent a missed opportunity to affect change in that direction.

The lack of differentiation of instruction is not discussed in Part II of this report. Yet it is one variable that needs to be considered when examining the mathematics learning of low achieving children. Examination of this variable might also shed light on children's behavior while playing games which is an important focus of this report. It would be worthwhile to analyze the data for the purpose of discovering whether there is any relationship between the children's mastery of prerequisite skills and concepts and their behavior when playing specific mathematical games.

Manipulative Materials and Games. Part II of this report mainly describes the many manipulative aids and games that were used in the observed classrooms and the manner in which they were used. That so many manipulative aids and games (83 out of a total of 105 teaching activities) were used is a very positive result. Suydam and Osborne (1977) report that ". . .many teachers use no instructional materials except the textbook and the chalkboard (p. 114)." They also report that "Across a variety of mathematical topics, studies at every grade level support the importance of the use of manipulative materials (p. 104)." So the teachers who participated in this study are meeting an objective that is considered to be of prime importance in the teaching of mathematics in the elementary school. Such a result is probably due to the influence of the MPS's on the teachers observed.

Since manipulative materials and games are the major focus of Part II of this report my comments in this section will be far more extensive. In some cases I will refer to the case studies themselves to support my points. First, I will discuss the ways in which manipulative aids are used by some of the teachers, aides, and MPS's and in so doing try to elucidate the translation problem described in the report (Part II, p. 30). Second, I will try to show that some of the children's behavior observed in "game groups" can be explained in terms of curriculum concerns. This does not mean that I do not appreciate the insight into mangerial problems and gamemanship skills brought out in this report. However, I think that the problem is much more complex then what is presented in this report. Curriculum concerns such as the sequencing of mathematics content and the selecting of games that relate to the mathematics being taught in the instructional groups contribute to the situation. And of course, the lack of differentiation of instruction discussed in the last section is another factor in this complex situation.

Prior to discussing the use of manipulative aids, it is worthwhile to review their role in mathematics learning. According to Engelhardt (1980):

> If the development of mathematics concepts naturally proceeds from manipulation to visual images to symbolization, then instruction should be such that it promotes this natural sequence (p. 32).

Engelhardt and many other researchers in mathematics education accept this sequence. When discussing this sequence Engelhardt (1980) reports that Glennon and Wilson (1972) caution that merely using concrete, pictorial, and symbolic materials is not sufficient for learning, but that

> one learns by thinking about what he is doing. And thinking can be done while a person is working with concrete things, or with pictures of things, . . .or with symbols (p. 309).

Engelhardt also notes that Wittrock (1973) emphasizes that it is not the materials themselves that generate learning but rather that it is the child's active involvement in the learning. Wittrock (1973) states that the ". . .learner must actively construct meaning if he is to learn with understanding (p. 30)." Thus, one way to analyze instruction that makes use of manipulative materials would be to see if the teacher has designed a setting in which children are encouraged to think about what they are doing.

Included in Part II (p. 34) of this report is an excerpt from Case Study H in which third grade students are having difficulty with writing multiplication equations to fit pictorial set models in their textbook. Examination of Case Study H reveals that the children in this classroom have received instruction on the meaning of multiplication equations using various concrete and pictorial models. Then, how can one account for the students' inability to do the activity in the textbook? The problem may be one of confusion in terms of how multiplication equations are related to models. In five different lessons taught by the teacher, the aide, or the project assistant (H, pp. 3, 4, 7, 19 and 21) the meaning of the two factors in multiplication sentences as they are related to set models were reversed, by the instructor, from the standard way of doing it. Textbooks and other mathematics curriculum materials always have the first factor in a multiplication sentence indicate the number of equivalent sets and the second factor indicate the number in each equivalent set. Therefore, 3 x 2 = 6 would be modelled with three groups of two beans. In one of the above mentioned lessons the aide associated two cups with four white cubes in each cup with the equation 4 x 2 = 8. Whereas, the MPS who taught two different groups during this time period modelled 3 x 5 = 15 and many other examples correctly--that is, in the standard way. It is little wonder that some children had difficulty in writing equations for a pictorial model. To an adult who is accustomed to the idea that 3 x 5 = 5 x 3, this might seem like a trivial distinction, but for children just beginning to learn about multiplication this type of inconsistency can cause confusion. Sowder (1976), when describing cirteria for mathematical models, emphasizes the importance of a consistent interpretation of a model for a given mathematical concept.

Occasionally it is possible to observe a child recognizing a mathematical relationship while using concrete materials and then being incorrectly "corrected" by the teacher. Consider the excerpt from Case Study G included in Part II of this report (pp. 4-5). The children appear to be first modelling a multiplication sentence and then writing a related division sentence. The problem is that the aide who is leading the group will not accept 8 ÷ 1 = 8 as a division sentence related to 8 x 1 = 8. The only correct division sentence that she will accept is 8 ÷ 8 = 1. The same occurs for 4 x 1 = 4; 4 ÷ 4 = 1 was accepted but not 4 ÷ 1 = 4. So here is a case of two children, Juan and Jackie, making a correct relationship between multiplication and division but being told that it is an error. Yet two examples later, 10 ÷ 2 = 5 and 10 ÷ 5 = 2 are both accepted as related division problems for 5 x 2 = 10. What must these children think about division by one?

Another point to be made concerning the dialogue reported in this excerpt is the lack of discussion relating the mathematical equations to the models. This phenomena was observed in many of the case studies. This lack of discussion by teachers relating models to equations may partially explain children's difficulty in making the transfer to the abstract level.

When the MPS's were involved in instructing children with the aid of concrete materials, they often expressed and had the children explain the relationship of the model being used to the mathematics being studied. (For two examples, see H, pp. 13-17, and F, pp. 8-14).

Thus, we can conclude that the mere presence of manipulative materials does not guarantee that mathematical learning is taking place. What is needed, in addition to the manipulative aids is explanation, discussion, and in general, verbal interaction between teacher and pupil concerning how the models relate to the mathematics.

Two types of games are described in this report: games that provide practice of previous instruction and games that were used as vehicles for instruction to help children develop new mathematical concepts. Due to time and space constraints I will only discuss games used for practice.

In the report, the principal investigator includes many excerpts from the case studies that illustrate that some games were not played successfully when an adult was not present in the group. Good management and gamemanship, as well as the presence of an adult leader, were seen by the investigator as being the important variables in a successful game activity. I would like to propose that some curriculum factors are also related to whether or not children were interested in playing the games and whether or not the games accomplished their purpose.

For example, Class B (B/C) had been exploring counting and place value and their relationship with set and measurement models. The instruction was well thought-out and had a very logical sequence, both mathematical and in terms of learning theory. All activities and games used in this classroom had a kind of unity that was apparent to the children. All of the games reinforced ongoing instruction. Children in this classroom were excited about what they were learning and about completing long range tasks. When a new game, called "Star Wars," was introduced to help children practice identifying the ones, tens and hundreds places in numbers, the children had a lot of background experience to bring to the task. Pairs of children were observed successfully playing the game independently. The aide in classroom B was definitely a help in managing the classroom, but I don't think the aide's presence alone was the reason why games were an effective teaching tool in this classroom. The well-planned curriculum and the children's awareness of the objectives of the mathematics program seemed to have fostered a climate for learning and co-operation.

Classroom C (B/C) on the other hand is an interesting contrast to classroom B. Many descriptions of groups of children from class C are included in Part II of this report to illustrate children's inability to play games independently. I think that there are a number of factors producing this situation in addition to there not being an aide in this classroom. Not that an aide wouldn't have helped. The main curriculum strand that was taught to the instructional groups was addition of whole numbers. The teacher progressed from addition of three one-digit numbers to addition with regrouping during the period observed. Some of the independent work that the children were involved in reinforced this instruction. However, none of the games used except for one, were well-integrated into the instructional program. Following is a list of the games used in this classroom and a brief description of the mathematical skill to be practiced:

One-Up, a card game, requires the children to count by one. This is very easy for third grade children. This game is not challenging enough to maintain children's interest for long.

Two-Up, a card game, requires children to count by two. This game would be more appropriate during a unit on multiplication.

Batter-Up provides practice of subtraction facts. It also requires a good deal of knowledge of the rules of baseball. It was not related to the instruction in addition. The observations reported in Case Study B/C indicate that some children in this class were having problems with knowing their subtraction facts. But one isolated game is not going to solve this problem. These children need a well-organized sequence of instruction that will provide them with strategies that will help them in memorizing the subtraction facts. Since no instruction was being given in this area that could help the children make progress, the game might have been a frustrating reminder of something they knew they couldn't do.

Zooks is an addition game but it only provides practice for sums of ten. A problem with this game is that the very nature of the response mode "yelling" Zooks first seems to be a natural for noisiness and discord.

The Beanbag Game played on the second day of observations was a success. It provided practice in adding three one-digit numbers, the focus of a preceding lesson.

From this description of the games used in classroom C, we can see that the teacher did not choose games that were directly related to instruction. As a result the mathematics program lacked unity and the children did not seem to be aware of any well-defined objectives for their playing the games. I think the children's disinterest, discord, and frustration are all related to the particular games being played.

From reading this report and the eight case studies I have compiled the following list of suggestions that might help make "practice game" groups more manageable in elementary classrooms:

1. Games should be chosen that reinforce present instruction.

2. When selecting games, teachers should try to foresee problems in terms of children's behavior. Example: "Yelling" in Zooks.

3. An answer key of some type is a must if children are to play games without an adult present in the group. A calculator is an appropriate check in many games involving whole numbers.

4. An adult should play at least one complete round of a new game with the children, explaining rules and reinforcing appropriate mathematical and personal behavior. This will also give the teacher a chance to see unexpected problems that arise.

5. The game group is a good spot for a teacher aide or a parent helper. When an adult is not available, the smaller the group the better, one game for each two or three children.

6. Consideration must be given to the complexity of the game. There must be a delicate balance between the format and the mathematics being practiced. The format must be clear and interesting and the mathematics should be at the children's instructional level.

Conclusion

Most of the mathematics instruction described in this study is not typical of most elementary mathematics classrooms. Small group instruction and the use of manipulative materials and games are positive indicators that change from whole-group textbook teaching has occurred in some of the observed classrooms. Most mathematics education research would indicate that this is a very desirable situation. That this is occurring in these classrooms indicates that some factor is involved in motivating the teachers to change. It is obvious from reading the case studies that a significant factor in producing and maintaining this learning environment is the support services offered by the Mathematics Project Specialists.

The data suggests to me that the teachers who have incorporated grouping and the use of nontext materials are now good candidate for continued change in their teaching of mathematics. I would suggest that they need (1) some diagnostic techniques that will allow them to group children based on common needs and (2) additional knowledge of the sequence of skills and concepts that comprise each mathematics curricular strand. I think that knowledge in these two areas would provide the base that would allow them to vary instruction.

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APPENDIX A

Table 1
Observation Schedule for the NIE
Classroom Implementation Study

Case Study	Grade(s)	Time of Year	Days	Hours	Minutes
A	4/5	October 6 - November 5, 1980	13	17	11
B/C	2/3	October 13 - November 10, 1980	13	13	7
		and March 11 - April 1, 1981	5	5	11
D	2/3	October 20 - November 12, 1980	10	7	44
E	5	January 19 - February 16, 1981	16	21	25
F	4/5	January 26 - February 25, 1981	15	16	25
G	3	February 25 - March 30, 1981	10	11	55
H	3	January 28 - February 26, 1981	14	14	46
I	4/5	March 6 - 26, 1981	10	10	--
		TOTAL	106	118	11

Table B-1. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study A

		Type of Activity		
Activity	Adult/Peer/ Independent	Game	Other Manipulative	Non-Manipulative
1. Measurement: metrics, perimeter, area, beginning concepts (pp. 3-6)	Teacher		X	
2. Finding area - textbook lesson (pp. 7-8)	Teacher/ aide, then independent			X
3. Same (pp. 7-8)	Teacher			X
4. Measurement - 3 groups: measuring stride, area of shapes, geoboards (pp. 12-14)	Teacher, Aide, MPS		X	
5. Comparing areas (textbook lesson) pp. 14-15	Teacher			X
6. Metrics - basic equivalencies and estimation (pp. 15-16)	MPS		X	
7. Estimation with beans and meter square (pp. 18-19)	MPS		X	
8. Metric perimeter and area - outdoor lesson (p. 20)	Teacher		X	

Table B-2. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study B/C

		Type of Activity		
Activity	Adult/Peer/ Independent	Game	Other Manipulative	Non-Manipulative
1. Counting: egg cartons, etc. (pp. 2-3)	B: Teacher		X	
2. Bean bag (pp. 3-5)	C: Teacher	X		
3. (Same as 1)	B: Child Description		X	
4. Ten Blocks: addition (pp. 7-8)	C: Teacher		X	X
5. Spin A flat (p. 9)	B: Peer	X		
6. My Computer Card (p. 9)	B: Peer	X		
7. Counting (pp. 9-10)	B: Teacher		X	
8. One Up (p. 10)	C: Parent	X		
9. Two Up (p. 11)	C: Peer	X		
10. Two Up (p. 12)	C: Peer	X		
11. Zooks (pp. 13-14)	C: Peer	X		
12. Ten Blocks: addition (pp. 14-15)	C: Teacher		X	X
13. My Computer (pp. 16-17)	B: MPS	X		
14. Star Wars (pp. 17-19)	B: Teacher, Aide, Child Dyads	X		
15. Batter Up (pp. 19-21)	C: Peer	X		
16. Zooks (pp. 21-22)	C: Peer	X		
17. Zooks (pp. 22-23)	C: Peer	X		
18. Rods: Place Value (p. 23)	C: Teacher		X	
19. Individual activities	C: Independent	X	X	X
20. Block Exchange (pp. 26-29)	C: MPS	X		
21. Riddle (pp. 29-30)	C: Child	X		

Table B-3. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study D

		Type of Activity		
Activity	Adult/Peer/ Independent	Game	Other Manipulative	Non-Manipulative
1. Odd-even Numbers (pp. 2-3)	Aide			X
2. More/Less - workbook lesson on charts/graphs (pp. 3-5)	Teacher			X
3. Zero facts, addition of doubles, double facts - recitation (pp. 7-9)	Teacher			X
4. Doubles Addition Dice Game (pp. 10-11)	Teacher/Aide	X		
5. Drag Strip (p. 12)	Student Teacher	X		
6. Domino Cut-outs - doubles facts (pp. 13-14)	Teacher/ Independent		X	
7. Doubles Dice Exercise (Appendix A, pp. 1-2)	MPS		X	
8. Drag Strip (Appendix A, p. 2)	MPS	X		
9. Same as 7 (Appendix A, pp. 4-5)	MPS		X	
10. Same as 8 (Appendix A, pp. 5-6)	MPS	X		
11. Zooks (Appendix A, p. 6)	MPS	X		
12. "Zero plus" basic facts (Appendix B, pp. 1-4)	Teacher			X
13. Zooks (Appendix C, p. 2)	Student Teacher	X		
14. "Zero plus" folding exercise (Appendix C, pp. 2-3, pp. 3-4)	Teacher			X

Table B-4. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study E

Activity	Adult/Peer/ Independent	Type of Activity Game	Other Manipulative	Non-Manipulative
1. Roll-and-Add (reverse of Roll-and-Remove) fraction game (pp. 3-5)	Peer	X		
2. Game of "One" (p. 6)	MPS	X		
3. Same - with Visual Aids (p. 7)	MPS	X		
4. Fractional Number - lines (p. 8)	Teacher		X	
5. Pattern Block Puzzles (pp. 9-10)	MPS		X	
6. Fraction addition (pp. 10-11)	Teacher			X
7. Fractional Cover-Up (Appendix B)	Teacher, then peers	X		
8. Pattern Block Puzzles (Appendix C, pp. 1-2)	MPS		X	
9. One/I Can't Believe I Made the Whole Thing (Appendix C, p. 3)	MPS	X		
10. Pattern Block Cover-Up (Appendix C, pp. 4-5)	MPS	X		
11. Fraction Equivalencies (Appendix C, pp. 5-6)	MPS		X	

Table A-5. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study F

		Type of Activity		
Activity	Adult/Peer/ Independent	Game	Other Manipulative	Non-Manipulative
1. Division Problems (textbook lesson) (pp. 3-4)	Teacher			X
2. Pattern Block fraction comparison (p. 8)	MPS		X	
3. Pattern Block fraction "language" (pp. 8-9)	MPS		X	
4. Fraction-folding (pp. 9-10)	MPS		X	
5. Pattern Block fraction fraction equivalency (pp. 10-12)	Teacher		X	
6. Roll-and-Remove (pp. 13-14)	MPS	X		
7. Roll-and-Remove and "I Can't Believe I Made the Whole Thing" - teacher-devised combination (p. 15)	Teacher	X		
8. Same (pp. 16-17)	Teacher	X		

Table B-6. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study G

Activity	Adult/Peer/ Independent	Type of Activity Game	Other Manipulative	Non-Manipulative
1. Egg carton and Bead Multiplication/Division "facts" (pp. 3-4)	Aide		X	
2. Cuisenaire Rod and Graph paper Multiplication/Division "facts" (pp. 5-7)	Teacher		X	
3. Multiplication Bingo (pp. 7-8)	Aide	X		
4. Block Exchange (pp. 9-10)	MPS	X		
5. Flannelboard fractions (basic concepts) (pp. 10-11)	Teacher		X	
6. Pattern Block Comparison (basic concepts) (Appendix A, pp. 3-8)	MPS		X	
7. Pattern Block Cover-Up (Appendix A, pp. 8-11)	MPA	X		
8. Making Roll-and-Remove games - fraction concepts (Appendix B, pp. 2-11)	Aide		X	

Table A-7. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study H

Activity	Adult/Peer/ Independent	Type of Activity Game	Other Manipulative	Non-Manipulative
1. Multiplication (x o) portion cup (p. 3)	Peer/ Independent		X	
2. Same (p. 3)	PA		X	
3. Constructing fact sheets (p. 5)	Volunteer			X
4. Worksheet (p. 6)	Aide			X
5. Grids: visualize multiplication facts (p. 7)	PA		X	
6. Grudge (p. 8)	PA	X		
7. Obey the Signs (p. 9)	Teacher	X		
8. Grudge (p. 10)	PA	X		
9. Bingo (p. 11)	Volunteer	X		
10. Worksheet	Aide			X
11. Shake-A-Score (pp. 12-13)	Teacher	X		
12. Geometric Shapes: to teach multiplication	MPS		X	
13. (Same as 12)	MPS		X	
14. Rods, clock: counting by 5's (pp. 17-18)	Aide		X	
15. Old Strawberry (p. 20)	MPS	X		
16. Board lesson, 5's facts (p. 21)	Teacher			X
17. Worksheet: pictures and equations (pp. 21-22)	Independent			X
18. Concentration (pp. 22-23)	Peer	X		
19. Array center (pp. 23-24)	Volunteer		X	

Table B-8. Content Analysis of Number and Type of Classroom Activity Structures Described in Case Study I

		Type of Activity		
Activity	Adult/Peer/ Independent	Game	Other Manipulative	Non-Manipulative
1. Fraction addition (pp. 4-7)	Teacher/Aide			X
2. Same (pp. 7-11)	Teacher			X
3. Same (pp. 11-13)	Teacher			X
4. Hexagon Worksheet (pp. 13-14)	MPS		X	
5. I Can't Believe I Made the Whole Thing w/Pattern Blocks (pp. 14-15)	MPS	X		
6. Same (pp. 15-16)	MPS	X		
7. Pattern Block Fraction Addition (p. 17)	MPS		X	
8. I Can't Believe I made the Whole Thing w/cards (p. 18)	MPS	X		
9. Cuisenaire Rods for L.C.D. in Fraction Addition	MPS		X	
10. "War" with Fraction cards (p. 21)	MPS	X		
11. "One" fraction cards (pp. 21-22)	MPS	X		
12. Fraction addition test (pp. 23-24)	Independent			X

Classroom Implementation Study of An Activities-Based Supplemental Mathematics Program

PART THREE:

EIGHT DISAGGREGATED CASE STUDIES

Final Report to the
National Institute of Education
United States Department of Education

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Department of Legal and Research Services
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CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED SUPPLEMENTAL MATHEMATICS PROGRAM

ABSTRACT

This research described the classroom implementation of a supplemental activities-based mathematics project designed for low-achieving students. The research describes the development of applied ethnographic methods for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. A model for use by school district evaluators in conducting ethnographic evaluation studies was developed.

The research consisted of ethnographic observations of mathematics lessons and student learning in nine classrooms in Grades 2 through 5 in eight schools serving low-income attendance areas. Observations were conducted over approximately a five-week period by four trained ethnographic assistants. Observations were scheduled before, during and following the delivery of classroom services of Mathematics Project Specialists.

Protocols of each observation, including those of the mathematics inservices, served as the basis for case studies produced for each of the eight sites.

Themes emerging from the study indicated that the predominance of classroom structure, the conditional nature of classroom teacher-resource teacher collaboration, teacher inservice, and teacher's evaluations of subsequent student achievement growth were key factors in program implementation.

Ethnographic descriptions of mathematic classroom activity structures provided a number of insights into the contribution of mathematic games and other manipulative aids to the learning of low-achieving students.

CLASSROOM IMPLEMENTATION STUDY OF AN ACTIVITIES-BASED SUPPLEMENTAL MATHEMATICS PROGRAM

Executive Summary

This research describes an in-depth classroom implementation study of a supplemental activities-based mathematics project designed for low-achieving minority students. The research supplemented existing evaluation procedures to allow for the development of applied ethnographic methods in program evaluation. The focus of the study was the development of procedures for observing and describing the way programs are implemented using curriculum specialists, or resource teachers, to help teachers in the regular classroom to improve instructional services for economically disadvantaged minority students. The study also addressed questions arising in practice and in the research literature about the mathematics learning of low achievers in an instructional program using manipulative aids.

The research consisted of ethnographic observations of mathematics lessons and student learning in nine classrooms in eight schools serving low-income attendance areas. Observations (10-15) were conducted over approximately a five-week period by three trained ethnographic assistants. Classrooms observed were Grades 4/5, 2/3, 2/3 and 2 (fall), Grades 5, 4/5 and 3 (winter) and Grades 3 and 5 (early spring). A brief followup study occurred in spring in one Grade 2/3 classroom. Observations were scheduled before, during and following the delivery of classroom services of Mathematics Project Specialists.

An ethnographic methodology was used in an attempt to generate hypotheses, and accommodate the research to natural classroom and program implementation processes. While a number of research questions served to focus observations, an attempt was made to produce protocols that were richly descriptive of the classroom structure and interactional processes as they happen.

Protocols of each observation, including those of the mathematics inservices, served as the basis for case studies produced for each of the eight sites. Both the protocols and case studies were reviewed by teacher collaborators during a two-day research colloquium. The case studies presented a variety of classroom mathematics activity structures occurring over a period of a four- or five-week time span and illustrated the use of manipulative aids and games and student responses to them, in a variety of contexts. Data presented in the case studies suggested that the successful participation of low-achieving students in the instructional process is increased by a multigroup, multitask structure when teaching with manipulative aids.

A number of themes emerged from the study regarding program implementation. Major themes include the following:

1. The ambiguity of the resource teacher role resulted in a wide variance in the scope, structure and quantity of services to different classrooms. Offsetting this were carefully planned, well-articulated half- and whole-day mathematics inservices. Teachers felt the inservices were an essential element in enabling them to implement the program.

2. There were a number of conditions to classroom teacher, resource teacher collaboration. These included teacher control of the classroom, group management, content to be taught, amount of time to be spent in the classroom and sharing or nonsharing of methods and materials.

3. Preexisting classroom structure before entry of the resource teacher, and/or concern for total class management had a determinant affect upon how the resource teacher fit into the classroom.

4. The prototypic model for classroom teacher/resource teacher collaboration appeared to be that of a team teaching rather than a demonstration model. Although some other styles of direct services of resource teachers were observed, the team-teaching model seems to depict the most acceptable (to both classroom teacher and resource teacher) participant structure for the implementation of the resource teacher service delivery strategy.

5. Some teachers evaluated the effectiveness of an activities approach to mathematics, and of the resource teacher services with tests administered shortly after the delivery of resource teacher services. Student success or failure on the tests, despite some mismatch between the curriculum focus and test items was seen to be reflective of the effectiveness of the program. This was indicative of the need for appropriate and specially designed evaluative end-of-unit tests to be used by teachers in evaluating student learning.

6. Program "treatment" was found to be nonuniform. There were a wide variety of local school and classroom contexts and extenuating circumstances influencing implementation including, (a) wide variation in time allocated for mathematics, (b) stability/change of principal and faculty of school staffs, (c) extra adult assistance in the classroom for program implementation varied from none to three, (d) a wide range of direct resource services given to any one classroom from 4-14, and (e) there appeared to be a wide variance in curriculum scope, e.g., number of concepts, terms and complexity of mathematics skills, covered on a topic among classrooms.

7. The mathematics program was partially defined as it was being implemented. One value of direct services of resource teachers

has been to enable them to modify, refine and further develop the program as a result of their experience in the classroom.

The study provided a number of insights into the contribution of manipulatives and games to the mathematics learning of low-achieving students. The observational data suggested that manipulative aids such as Cuisenaire rods and pattern blocks were very appropriate for the instruction/learning of the low-achieving student. Often low achievers were more successful doing manipulative activities than other math activities. However, in using manipulatives for instruction, students must first be taught the meaning and use of the technology of manipulatives. The data provided numerous examples of teaching children the meaning of, and even how to construct, manipulative aids. Much guidance to individual students was observed in the use of this instructional strategy, and because of this, small-group instruction seemed more appropriate, especially for low-achieving students, than whole-group instruction.

The skillful use of manipulatives in instruction required a high degree of teacher/aide training. This was provided in the inservices, as a first step, (sometimes followed by demonstrations) and facilitated through the use of worksheets that could be used within the guided instructional process to help teachers structure the lesson. Some of the worksheets as well as other activities were invented by the resource teachers to help classroom teachers 'think like mathematicians' in the instructional process. Also worksheets were used to help students make the transition from the manipulative level to the symbolic level.

In most classrooms students were observed playing mathematical games. However the role games played in instruction varied, as did student response to the games. Teachers seemed to view games as either a teaching strategy, i.e., games were used as a part of instruction and learning new concepts and facts, or for use as maintenance of skills already learned. Sometimes games were used as an independent small-group activity but this was difficult to manage without the supervision of an aide or other adult in primary grades. Also groups of younger students, Grades 2-3, appeared to have difficulty in managing the competitive aspect of the games without supervision. Training in gamemanship appeared helpful and was sometimes provided by the resource teachers. Game playing of self-selected partners was more easily managed on an informal than an assigned group activity basis when adult supervision was unavailable.

Games appeared to be a potentially useful way to diagnosis individual skill attainment and give individual assistance in skill and concept development to small groups of students. When observing games used as a teaching strategy, it was clear that individual low-achieving students benefited from adult help.

This study describes an applied ethnographic model that can be adopted by school district evaluators to study program implementation within classrooms. The model describes (1) setting the context with program implementators, building principals, teachers and students for conducting an observational study, (2) ethics of ethnographic research, (3) training classroom ethnographers, (4) developing procedures for data collection and reduction, (5) analyzing the results and (6) reporting the results.

This research was divided into three sections; Part One: An Ethnographic Evaluation of Program Implementation, Part Two: Mathematics Learning of Low Achieving Students Through Mathematics Games and Other Manipulative Aids, and Part Three: Eight Disaggregated Case Studies.

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Part Three:

Eight Disaggregated Case Studies

PREFACE

These case studies summarize periodic observations over a four to six week time interval of the classroom mathematics program in nine classrooms in eight elementary schools receiving ESEA Title I funds and participating in a Title I Mathematics Resource Project. Ethnographic observations were conducted of mathematics lessons before, during, and after services of Mathematics Project Specialists were given to low achieving students within the classroom. Excerpts from protocol descriptions of classroom mathematics activity structures involving low achieving students form a major part of the case studies. The methodology used in this study was described in Part One.

Four ethnographic assistants were trained to conduct observations and write protocols of program implementation and the classroom mathematics program at each of the research sites. The ethnographic assistants prepared written protocol accounts of each observation; these protocols, supplemented by those written by the principal investigator and discussions of the program among researchers, teacher collaborators and mathematics project specialists, formed the basis for the case studies. The case studies and protocols were reviewed by teacher collaborators and mathematics specialists. All of the ethnographic assistants produced protocol data useable for the purposes of the study and assisted in the review and analysis of the data. One ethnographic assistant, Peggy Placier, in addition provided cogent analyses of the implementation at two sites, F and I, partly based upon a preliminary version of the study (Slaughter and Chilcott, 1981). These analyses are included for these two case studies only. The ethnographic assistants who conducted classroom observations and wrote protocols for the other sites were Lisa Leiden (D), Barbara Markert (B/C, H) and Judy Walters (A, E, G).

An abbrieviated guide to the specific mathematics units, grade level and implementation features of each study follows:

Case Study A. This case study describes a Grade 4/5 combination classroom teacher implementing an activities approach to teaching measurement concepts, e.g. area and perimeter, to a group of Yaqui and Mexican American students in the fall. This approach was in sharp contrast to the teachers regular method of teaching mathematics, and the teacher was disappointed with student results on textbook tests.

Case Study B/C. This case study describes a team teaching situation where one Grade 2 and one Grade 2/3 teacher had planned ahead the previous summer to implement an activites approach utilizing the Title I Mathematics Resource Project materials, ideas and services. This study took place in the fall when teachers were in the midst of initial implementation and protocol data illustrates classroom mathematics activity structures involving manipulative aids and mathematics games. The two classrooms were multi-ethnic in student background.

A brief followup study occurred in this site in the spring, thus providing a longer view of program implementation.

Case Study D. This study describes a Grade 2/3 combination classroom using a manipulatives approach and using grouping to teach basic facts of single-digit addition, e.g. the zeros facts and doubles. The students were Mexican American and attended a school containing a very high percentage of low income families. Observations included examples of bilingual instruction.

Case Study E. This case study describes an attempt at program implementation in a Grade 5 classroom in a school where students were being pulled out in small groups for a variety of compensatory and/or enrichment programs. Protocol data shows students playing mathematical games and receiving instruction from teacher and Mathematics Project Specialist in visual/spatial concepts of fractions through the use of manipulatable aids.

Case Study F. This study describes a team teaching arrangement between a Grade 4/5 classroom teacher and Mathematics Project Specialist in teaching fractions concepts, i.e., the eighths family, through manipulatable aids and games.

Case Study G. This study, occuring in midwinter, shows a Grade 3 classroom teacher and her highly competent Title I classroom aide implementing a manipulatives approach to multiplication. The introduction of fractions concepts to low achievers by the Mathematics Specialist and later the teacher is also described.

Case Study H. This study, occuring in winter, shows a Grade 3 classroom implementing an activities approach to multiplication. This classroom was unique in that a school-based Title I project assistant had worked in the classroom almost daily for several months in a team teaching arrangement to implement the program. The classroom also had the assistance of a classroom aide and a regular volunteer. Some protocols describe bilingual instruction and the responses of monolingual Spanish children to mathematics games.

Case Study I. This study of a Grade 5 classroom in early spring contrasts traditional chalkboard instruction in mathematics used by the classroom teacher with a manipulatives approach used by the Title I Mathematics Project Specialist. The majority of students in this study were Mexican American and protocols illustrate bilingual instruction.

Classroom Ethnography Case Study
for Research Site A

Context of the Research Setting

Teacher A volunteered to participate in the study as a result of her interest in ethnographic research and in this approach to evaluation. She had not previously participated in the classroom services component of the Mathematics Resources Project. The ethnicity of the children was approximately 50 percent Yaqui and 50 percent Mexican American. The teacher was Anglo and the aide was Mexican American. This was a split grade classroom with Grade 4 students and Grade 5 students. Only Grade 5 low achievers were eligible for Title I participation. Initially 4 students were identified but one became disqualified when he was selected to receive Learning Disabilities services. However, we included him in our observations. The achievement level of the classroom was considerably lower than average and more students would have been eligible for Title I services if the criteria had not been so low and if Grade 4 students had been included in the project. Then too, as the study indicates, here and at other sites, the identification of children in need of special math help seems to shift over the year for several reasons that will be mentioned in the report on eight sites.

The classroom mathematics program was initially organized through individual student contracts and the first observations are of students working on contracts. The teacher reorganized her classroom instructional program during the time the study took place in teaching a unit on measurement. This was done partly to accommodate both the research and the use of mathematics resource teacher help within the classroom. This was planned at this time to teach students measurement skills that could be used out-of-doors in the desert at the district camp. Planning for the research included an after school meeting among teacher, principal investigator and ethnographic assistant (EA) to discuss ground rules for conducting the study. The teacher suggested that the EA not assist students with their work because the children already seemed too dependent upon adult help and she would like us to study this phenomenon. Planning for the mathematics project classroom intervention occurred among the teacher, mathematics project specialist and principal investigator. During this meeting the mathematic topic, e.g. measurement, was determined and several suggestions were made by the Mathematics Specialist regarding materials and activities that could be provided to the classroom to supplement the teacher's unit. A time schedule was agreed upon for the Mathematics Specialists in-classroom assistance to the teacher.

Organization of this Report

This report describes periodic observations (13 one-hour, 15 minutes), over a five-week time span of a classroom mathematics program. Major points are illustrated by excerpts from protocols written for each observation day. These are indexed by study identifier letter, date of observations and protocol page number. All names are fictitious and do not reflect ethnicity for the most part. The names of Title I project participants are marked with an asterisk.

Pertinent names are:

Mrs. A	Classroom Teacher
Mrs. N	Classroom Aide
Mrs. M	Title I Mathematics Project Specialist

Irma, Obie, Roxanne and Vic were Title I target students (Vic was later identified as a student with learning disabilities).

First Observations

The first observations describe a situation where students are working on contracts exemplified as worksheets on the topic of multiples at their desk or at a back table. Whether at tables or desks, children worked together (exchanging directions and answers) and individually. The mathematics period was from 10:45 to 12:00 daily. During the first observation both teacher and aide were observed providing individual help to students during the entire math period. Children were constantly requesting help from either the adults or each other. Some children were taking a unit test which was included as part of the contract.

Day 1 (A, 10/6)

> . . .Mrs. A is helping students at their desks, Mrs. N, the aide, is helping students at the two back tables. A student (Neil) removes a chair from the rectangular table and goes to the front room table to sit with another student, Stephen, who has moved from sitting by Deborah. Deborah is told not to help Andy, he is taking a test. The girl sitting across from Abby, Wanda, plays with a pink roll eraser, and hasn't begun to work. . .
>
> . . .Mrs. N is with students at their desks; Mrs. A is back helping at the tables. A girl holding her contract and book leaves the circular table after Mrs. A has checked her work. One girl approaches Mrs. A and exclaims she's finished. Mrs. A tells her to do both sides and the girl returns to her desk. Vic* is frequently asking Mrs. A for help and she exclaims, "you're only asking for my attention, you know the answers!". . .

During the second observation day, the aide's absence poses a difficulty for the teacher in providing individual assistance to students.

Day 2a (A, 10/8)

> . . .Mrs. A tells the class to get their math mateials out and to get started. Mrs. A tells me that no two children are on the same place with their contract. These contracts will end Wednesday and all the students will begin a new section of math together. Even when all students begin a new section, contracts are given according to learning level. Several students shout "teacher" and approach Mrs. A with their books. Mrs. A announces "there is only one of me to help today. Please be more patient. If I have to stop to scold, I won't be able to help as many of you." 10:53. Hands are up for help; many students still wander the classroom for drinks and the restroom. Mrs. A erases two parts of a star, speaks two names and walks to help Fred. . . (The star was a symbol of the teacher's patience, after the star is erased she would write names on the board.)

The remainder of the protocol describes students requesting teacher assistance by raising hands or walking to where the teacher is for help throughout the hour. There are a number of students waiting for help. Also noted are students departing and returning for band and getting ready for patrol.

Collaboration Between the Teacher and Mathematics Project Specialist Before Entering the Classroom

The teacher (Mrs. A) and the MPS (Mrs. M) met at lunchtime in October, several weeks in advance of the week Mrs. M planned to be in the classroom to discuss the classroom implementation phase of the mathematics project.

The MPS asked how she could assist Mrs. A in her mathematics program. Mrs. A said that she would be beginning a measurement unit on perimeter and area, a unit that could be meaningfully extended to an outdoor camping experience planned for November. The MPS suggested several manipulative aids and activities the teacher could use in her unit and also some activities she herself would teach during the week in the classroom.

Beginning the Unit on Measurement

The discussion of the initial lesson on perimeter as derived from protocol data is given in detail as it describes the instructional context in which the Title I resource teacher would be working ten days later.

Teacher A began a new unit on measurement, i.e., find the perimeter, on October 17, a Friday. The fifth grade students had done this unit the previous year. The metric system was also introduced at the same time.

Day 3a (A, 10/17, p. 1)

> . . .At 10:50 the children returned from recess. They were told by Mrs. A to clear their desks. Mrs. A began the lesson by saying, "I am going to start a new unit in math. We won't leave the old unit though. We will be getting into measurement." Vic* says out loud, "we learned it last year." Mrs. A says, "good, I hope you remember." She proceeds. "I have some rulers, do you? The 'I don'ts' can stay quiet. This ruler is not to be used as a weapon, or you get a paper ruler." A student passed out the rulers. The aide was busy putting art supplies from last period away. Mrs. A goes on. "Look at your ruler. One side is in inches. How many inches are there?" A student says, "12." Mrs. A says, "12 is right. Inches is the English way for measuring, but we're going to study the metric system." She writes "metric and meter" on the board. Mrs. A says, "hold your ruler to look at the centimeter side. How many centimeters are there?" Students say, "30." Mrs. A says, "about 30." Mrs. A goes on to say, "I want you to measure something. Measure it and exchange the object with a friend for accuracy.". . .

The metric terminology was emphasized as the teacher gave separate directions to the two groups of children in Grades 4 and 5.

Day 3b (A, 10/17, pp. 2-3)

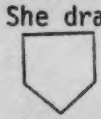
> . . .Mrs. A turns to the class from up front and says, "what are we measuring in?" Several shout, "centimeter." Mrs. A goes on. "Okay, we write centimeter, c e n t i m e t e r, or cm. is the abbreviation. Can you follow directions hearing them one time? If you are in the blue book, turn to Page 21. In the green book, turn to Page 156. The four of you who were at the rectangular table, after you get your book, ruler and pencil go back to the table." After the commotion of getting supplies out of their desks, Mrs. A asks, "ready to listen? Freeze. Hands down. Those in the blue book do Numbers 1-9. Width is across; length is the long way. Mark out Number 6. I don't know why they expect you to have a nail file." Irma* says, "but it's there, teacher!" Mrs. A remarks, "yes it is. Okay do it. Margaret pass out some paper. Use the word centimeter or the abbreviation." A minute later she

> says, "in the green book, label your answers centimeter also." At the rectangular table, Abby asks Mrs. A, "is this side centimeters?" Mrs. A replies, "yes.". . .

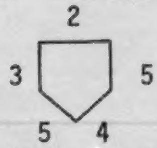
After the children have measured common objects using centimeters both in the room and those represented in the text, the concept of perimeter was introduced through another measuring activity.

Day 3c (A, 10/17, p. 5)

> . . ."I want you to draw a shape using your ruler on the centimeter side. I don't care what shape. Measure around your shape." She draws this on the board:



> She continues. "Use the back if you want." Vic* asks, "a crazy shape?" Mrs. A replies, "one you can measure; one that is closed. Find the perimeter. Write it down, but not on your paper, because your friend has to guess." At the rectangular table, Abby is making a star. Mrs. A states again, "find the perimeter of your shape, exchange papers. You are not ready to exchange until you find it yourself." The students are putting an imaginary fence around their shape. Mrs. A asks Vic*, "if you have three fours and a two, how do I know how much fence to buy? I need one number." 11:30 The aide and Mrs. A converse about a resource box on the circular table before the aide leaves. Mrs. A then turns to the class. "We have a problem. Freeze. Suppose you have



> pieces of yard. I need one number for buying centimeters of fence. How do you find the answer?" Vic* says, "add." Mrs. A says, "right, find your perimeter.". . .

A manipulatable aid that consists of white centimeter cubes, white rods which are ten centimeters long and one centimeter wide, and orange slabs which are ten centimeters square (The Power of Ten Kit) was briefly introduced to the whole class and used to illustrate finding the perimeter, near the end of the class period. The teacher used the analogy of a fence for perimeter. She also used illustrations on the board to explain the concept of perimeter.

Day 3d (A, 10/17, pp. 6-7)

> . . .Mrs. A turns to the class and says, "close your math book. Put it aside. You're going to be given something else to use. It'll take a minute for us to pass them out." Margaret and Wanda are passing out orange cubic slabs and sticks. Mrs. A tells the class, "put them down flat, so we have no crashes!" Irma* and Erwin are conversing in Spanish about a pencil eraser. Abby and Karen are still measuring their diagrams. Mrs. A holds up a slab, two rods and one cube. She tells Wanda, "we're all set, put the others (extras) away. Did they glue some small ones together, or cut the big ones apart? How many believe they glued the small ones together?" All raise their hands. No answer from Mrs. A. Mrs. A puts her hand up. Then the class is quiet she says, "measure to see how wide one cube would be." A student, "one." Mrs. A: "Okay, how long?" Students reply, "one." Mrs. A: "Okay how thick?" Students reply, "one." Mrs. A: "Okay, from corner to corner?" Students reply: "one." Mrs. A: "close to one." She then proceeds, "these are centimeter cubes. This is a ten centimeter rod. Holding the slab, "ten long and wide; how thick?" Students reply, "one." Mrs. A: "Right. What is the perimeter of the slab?" A few say, "10. . . 40." Mrs. A asks, "how many agree with 40?" Students raise their hands. Mrs. A says, "40 is right for my fence. How about the perimeter of the rod." Vic* shouts, "one." Mrs. A remarks, "no crazy answers by guessing? I'll call on someone. Irma* do you know the answer?" (She pretends to be working and Mrs. A leaves her alone.) She draws a square and a rectangle on the board:
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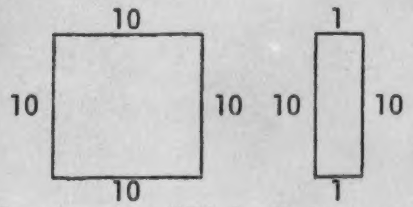
> 
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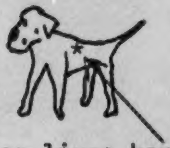
>
> and asks, "Irma*?" Irma* says, "22." Karen says across the table to Irma*, "I told you!" Mrs. A tells the class to make a bigger fence. . . .

On Monday, the second day of the unit, the term decimeter was explained and students were shown how to find the area and label it in square centimeters using rulers, graph paper and sometimes multiplying. An analogy of dog and flea was used to illustrate the concept of area. The target child Vic seemed to understand the lesson, while the target child Obie did not. During the lesson there were three interruptions, one to get a child from the room for band, one to borrow markers and a 15-minute trip to the cafeteria for class pictures.

The dog and flea analogy was first used to illustrate "perimeter."

Day 4a (A, 10/20, p. 2)

. . ."Now I have this flea and this dog. Here's the dog.



The flea lives here and he wants a fence so the dog won't scratch. I want to give my flea as much room as possible, but I only have 12 centimeters of fence. On your paper you will make plans for the fence. It will be a square or a rectangle. Use your ruler and each square will equal one centimeter. Use your pencil first as it can erase. Then trace it with a crayon. Count the edges; perimeter means edges. Count for the fence, not the inside. I'll draw on the board to illustrate. . . .

Then the analogy is used to illustrate "area."

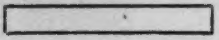
Day 4b (A, 10/20, pp. 3-4)

. . .Mrs. A says to the class, "my flea wants more space inside to bite. Which one gives my flea more room?" Students say, "first one." Mrs. A asks, "why?" Students, "it is wider." Mrs. A asks, "how do you tell the difference inside the boxes? You count the squares inside. The first one had nine. The second most space was eight. Jeff's way had seven, Wanda's had six. You all had different amounts of dog to bite. The area is the amount of dog to bite; perimeter is outside. Vic* had the most, it is nine square centimeters. Or with this one, eight square centimeters. If you want to shorten it, write 'sq.' You've learned perimeter and area.". . .

The difference between rectangle and square was also reviewed.

Day 4c (A, 10/20, p. 4)

. . ."And here's another. What shape is it?



"Rectangle," say a few students. "Why isn't it a square?" Vic* says, "not all are the same shape." Mrs. A, "right all the sides must be the same to be a square. Who got the biggest area for my flea? Wanda got the same as Barbara--11. Eleven what?" A student says, "centimeter; square centimeter." "Right," says Mrs. A, "11 square centimeters.". . .

The lesson ended with an assignment requiring students to apply the lesson by working out area problems in the textbook, divided by grade level. One student, Abby, appeared to have difficulty in the application process.

Day 4d (A, 10/20, pp. 6-7)

. . ."Green, Page 276. . .Blue, Page 58. I want to see the graph paper go to the back of the hardcover book. Next time we need graph paper it'll be there. In the blue book it describes the area of a rectangle. It shows you four rows of squares. You could add seven, four times or multiply four times seven. We're not finding perimeter, but the amount of dog inside. There are four problems but one answer for Number 1, three for Number 2. If you get an answer such as 24 centimeters, it is 24 square centimeters. You can abbreviate both. Now skip over to Number 6. There's no picture, but width is five and length is fifteen. Only do 1-8 in the blue book. In the green book, it is like your graph paper. You may add or multiply, but on odd shapes just count. For squares and rectangles you can multiply. Do 1-7." The students are using the text, Mathematics Around Us. Vic* announces, "seven minutes." Mrs. A hears Vic* and says, "seven minutes for seven problems; have your paper? Begin." To the class she says, "also in the green book, label your answers square centimeters; it is for area." A girl is handing out notebook paper. Mrs. A walks through the rows and says several times to students, "just the area, just the area." Abby has her hand up. "Okay," says Mrs. A. Abby says, "I write four times seven," and she starts to count each square. Mrs. A asks, "why are you counting? You know four times seven, what is it?" Abby, "24." Mrs. A, "no." Abby, "28." "Once you know," Mrs. A begins, "it's four rows of seven, just multiply." Abby, "is it 28 rows?" Mrs. A, "it is not 28 rows. How do

> you label 28 centimeters?" Abby, "28 square centimeters." Mrs. A walks to the front of the room and tells the class, "we're not interested in perimeter, but how much dog flea can bite; area. Label your answer in square centimeters. If you just put centimeter, I don't know you're talking about area." She glances at the clock and says, "I think most of you did not have time to finish. Put your paper in your book and the book away. There were too many interruptions.". . .

Tuesday's lesson continued instruction in finding area, extending the unit of measurement to decimeter and meter. The distinction between square and rectangle was again reviewed. Graph paper and The Powers of Ten Kit were used to illustrate concepts during the teacher's initial presentation to the class. Several interruptions outside, e.g., band, etc., occurred during the lesson as observed in previous protocols. The teacher found that students were having difficulty using the multiplication algorithm to solve area problems. The following excerpts show the aide assisting students with this process.

Day 5a (A, 10/21, p. 3)

> . . .11:05. The students take out their books, ruler and pencil. The aide is up helping the students on the far side of the classroom. Obie* asks the aide, "what page?" The aide replies, "Obie*, Page 58, 58, 58." Now she is with Carl. He asks how to find the area of a problem. Mrs. N (the aide) asks, "how many rows? How many squares?" Carl says, "five and four." Mrs. N then repeats, "five rows; four squares." Carl asks her, "do I multiply?" "Yes," she responds. . . .

Day 5b (A, 10/21, p. 4)

> . . .Fred has called Mrs. N to his desk. "How do you do this one?" he asks. Mrs. N reads the directions out loud. Fred asks, "do I times?" Mrs. N asks him, "what would you times? Times rows times squares equals the area." As she leaves his desk he tries to ask, "you would times?" But she's out of his range. . . .

The teacher also supplied the algorithm to individual students and later to the group.

Day 5c (A, 10/21, p. 5)

> . . .But when Mrs. A gets down to Problem 6, she finds that most have not finished. She tells the group, "you have to multiply to find the area. I want

> you all to take time to do these." Carl calls for help. Mrs. A goes to his desk. He tells her he needs help with a problem. Mrs. A looks at it and says, "a rectangle; fifteen in length and five wide." Carl repeats her word for word. "It would be five times fifteen, right?" She asks Carl. "And here's another, six times four." Carl asks her, "five times fifteen?" Mrs. A leaves with, "right.". . .
>
> . . .She returns to the front of the room; some are having trouble putting this into practice. She begins to write one of the problems on the board. "Find the area of a rectangle which is fifteen long and five centimeters wide." Fred shouts, "75." Mrs. A remarks, "don't shout out the answer. One, two, three, four, five rows. How many in a row?" Roxanne* says, "15." Mrs. A says, "okay, multiply five times fifteen.". . .
>
> Later, the teacher again shows the class the solution.

Day 5d (10/21, p. 6)

> . . .Mrs. A is up at the front. "The first one was five rows of fifteen. Let's multiply first and check it by adding. Either way you get . . ." Students say, "75." Mrs. A says, "75 square centimeters. Diane, what did you get for seven times seven?" Diane replies, "49." Mrs. A corrects her with, "49 square centimeters. Finally, a rectangle I'm not going to draw. . ."
>
> 43 ⌈ 26
>
> "I wouldn't want to add . . ."

$$\begin{array}{r} 43 \\ \times\ \ 26 \\ \hline 258 \\ 86 \\ \hline 1118 \end{array}$$

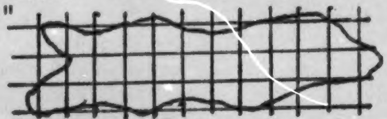
> "And the answer is 1118 square centimeters."

The lesson on Wednesday began with a whole group review of squared numbers using graph paper and diagrams on the board to illustrate the difference between a square and a rectangle. Then the teacher shifted to the topic of area and extended the concept of area to estimation of the area of an irregular shape, i.e., a lake, which the teacher felt most students had mastered. Vic, a target child, broached the topic of depth (or volume or cubic measurement) but this was not a part of the unit.

Day 6a (A, 10/22, pp. 2-3)

Mrs. A asks, "okay, Irma* what is next?" (Irma* has been goofing off at her desk.) Fred shouts, "ten rows of ten." Mrs. A quickly says, "hush! We have one row of one. . .two rows of two. . .three rows of three. . .nine rows of nine. . .what's next Irma*?" Irma* replies, "ten rows of ten." "Which is?" Mrs. A asks. Irma* says, "100." Mrs. A goes on, "okay. You know your multiples. Erase 'yes' and write 'squared numbers.' Now which is bigger, two rows of ten or four rows of five?" Preston answers, "four rows of five." Mrs. A replies, "they're the same." Andy speaks up, "remember teacher a ruler is one step" (footstep). Mrs. A answers Andy with, "before Camp Cooper we'll measure strides. How do you find the area of a lake?" Vic* quickly says, "jump in with your ruler." Teri picks up on the joking and says, "put a stick down. Mrs. A tells her, "that's depth." Vic* tries again, "take a tape measure. . ." Mrs. A interrupts Vic* with, "but that's not the whole area. Now a tape measure around is the perimeter. I don't want to know the length, width or perimeter.". . .

. . ."We're going to estimate the area. It's bigger than this much ---- less than this much ----." (She writes on the board as she talks.) Greater than ---- square centimeters, less than ---- square centimeters. Your paper is like this."



"Find all the squares that are complete. Not the one's that have land and water. Just color in the complete squares." (The aide is sitting at a desk by the art table.) As Mrs. A is wandering through the desks she says, "most of you seem to understand. If you have finished, write this ('greater than . . .') on your paper." It is 11:15. . . .

After this was accomplished, the students were asked to make measurements of their foot, coloring and recording the number of complete squares within the outlined shape and those on the edge. This was followed by a workbook activity requiring students to (1) draw shapes having a perimeter of 16 centimeters and (2) draw shapes having an area of eight square centimeters.

Classroom Organization and Instruction During the Time That the Mathematics Project Specialist Was in the Classroom

Monday, October 27, was the first day Mrs. M, the mathematics project specialist (MPS) was in the room. The teacher guided a review of area and perimeter with the whole group and the teacher aide and MPS, assisted individual students to complete an activity with graph paper and a worksheet. As an understanding of the term kilometer was required by the worksheet, this was defined. A combination of teacher recitation, organized whole group instruction and assistance to individuals constituted the first 55 minutes of the class period. Several students, including Irma, a target student, left and returned from band during the hour.

The resource teacher had already been introduced to the class when the ethnographer arrived at the usual time.

Day 7a (A, 10/27, p. 1)

> . . .At 10:45 the children are in from recess, the math specialist, Mrs. M, has been introduced to them, and they are seated to begin working. As Mrs. A is about to begin, Betty walks over to my seat on her way to her desk and asks for my name. Mrs. A walks to her desk and pulls out a sheet (lesson plan?) of paper. She briefly discusses with Mrs. M (MPS) what she has planned for today. Mrs. A turns to the class and says, "I want to review today, since I was gone Thursday and we had a field trip Friday. I'm going to give you graph paper and this," (ditto paper). Referring to the ditto, "if I ask for area, what do I want?" The students respond, "inside." Mrs. A agrees. "Okay, what if it's a square?" The students and Mrs. A say together, "it has to be four sides and even." Mrs. A looks to Gina and says, "Gina, pass these out and choose someone to pass out graph paper." Gina chooses Betty to help her. Mrs. A tells the class, "when you get both, put your name on both. Do your work in pencil first." Having their papers, students are up to sharpen their pencil, get a drink and quickly talk with friends. 10:48 Mrs. A, Mrs. N and the MPS are all helping students. . . .

Most of the observations were focused on Mrs. A, the classroom teacher. The protocol indicates that one target female student, Obie was requesting the same kind of help from both the aide and then from the teacher.

Day 7b (A, 10/27, p. 2)

> . . .Mrs. N is with Obie*. Mrs. N is going over every step of the problem with Obie*. For problem Number 1,

> she explains the difference between rectangle and square by counting the number of squares on each side. "For a square," she says, "they're all the same, but for a rectangle, two sides are longer." Obie* and Mrs. N count nine squares together. Mrs. N tells Obie* that the other problems should be done the same. But she must find the perimeter for each. Obie* then asks Mrs. N, "by counting lines?" "Yes," says Mrs. N. Fred, Irma*, Stephen and Teri leave for band. As soon as Mrs. N has left Obie*, she calls for Mrs. A. Mrs. A walks over to Obie* who asks about finding the perimeter for Number 1. Mrs. A answers her with, "count the lines of the fence.". . .

During the last 20 minutes of the period, the class was divided into three groups, one led by the MPS.

Day 7c (A, 10/27, p. 6)

> . . .Mrs. A says, "I have three meter sticks, one is broken, so I'll tape it. I'll divide you into three groups and give you a piece of chalk. On the floor, make a shape of one square meter. Use lines in the tiles to get you started, but measure using the meter stick." Mrs. A divides the class into three groups and places them in three areas of the room: the far side by the bathroom, the backside by the windows, and up front by her desk. I observe the group by Mrs. A's desk in which Carl, Irma* and Obie* are included. For their first problem, Carl wants the square even according to the tile lines, not the meter stick. Each side therefore measures 93 centimeters. Mrs. A gives them another problem: four square meters for an area. Irma* and Carl, who participated most in the first problem, show apathy as Abby sweeps the floor to get ready. Mrs. A asks the group, "are you giving up? You were my first group to finish problem Number 1. With that the group gets started again. Obie* tries to help with the problem and encounters some teasing. She leaves and goes to the bathroom. Carl, Obie*, Abby and Preston do most of the work for this problem. It was necessary for them to move several desks and chairs. When they finish, Mrs. A says, "you could play a game of four-square." 12:00. Mrs. A tells the group to be seated and to straighten out the desks. The MPS has told her group to do the same, but Mrs. A has to spend some time with her group before they get their answer and

> can return to their desks. The group I has been observing worked basically independently. . . .

After the class was over, the MPS and ethnographic assistant stayed to discuss the next day's plans during lunch period.

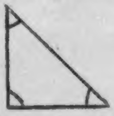
Day 7d (A, 10/27, p. 6)

> . . .The students leave. Mrs. A goes into the cafeteria and gets her lunch. She and the MPS discuss the week. They decide that before Camp Cooper measuring stride, measuring height and measuring with random sampling could be covered. A tentative plan for tomorrow will be to have the MPS teach measurement of stride and height also. Both Mrs. A and the MPS will use tape paper that will measure the students' present height, but leave room for an end-of-the-year measurement. Wednesday may be a good day for measuring and estimating with the use of lima beans and decimeters. We leave at 12:30. . . .

On Tuesday, the MPS discussed some math worksheets she has brought with her and specifics regarding the aide's role during the 15-minute recess before class. The class was divided into three groups led by the teacher, MPS and aide. Two students, Diane and Abby, returned from band after the first group session.

Day 8a (A, 10/28, pp. 1-3)

> . . .Mrs. A tells the class, "today we have a lot of help, so I'm going to divide the class into three groups. Mrs. N's (the aide) group will be working at the art table with geo-boards. My group will be by the overhead, working on shapes and their names. Mrs. M's (the MPS) group will work with a trundle wheel and measure stride, and also measure height in centimeters. If you are called to Mrs. M's group, you will need a pencil, but not for Mrs. N or myself." Mrs. A then reads off the names in each group. She notices that Roxanne* is absent today, and so are two others. 10:55. Mrs. M's first group consists of: Wanda, Irma*, Betty, Carl, Vic*, Fred, Margaret and Stephen. In the hallway, the MPS explains to the children that she would like for them to have a measurement of their height now and next spring, therefore several inches of tape will be given in addition. The students are paired off and asked to measure each other in centimeters. 11:00. I reenter the classroom. I sit at the rectangular table adjacent to Mrs. A's

> group. They are located in the back of the room with an overhead projector placed in the center of the carpeted area. Included in this group are: Obie*, Preston, Henry, Teri and one other child whose name I do not recall. They are sitting in a semicircle with Mrs. A standing next to the projector. . . .
>
> . . .Mrs. A is drawing shapes on the overhead, labeling the sides and angles and writing the names. For example,  she has written, "3 sides. . .3 angles. . .triangle." The students are holding their texts that they were asked to bring with them, green and blue, Mathematics Around Us. After going over at least half a dozen shapes, Mrs. A has the students open their books. She wants them to all look on Page 74 of the green book, so she pairs those with blue books with someone else. 11:05. At this point I leave Mrs. A and wander over to Mrs. N's group which includes: Deborah, Gina, Jeff, Andy, Barbara, Clyde and Neil. The aide has given each child a geo-board. The boards are peach-colored, flat, in the shape of a square; one side is sunken in about one-half an inch with 25 outlined squares, and a small peg is in the center of each square. She has also given the students several rubber bands. She asks them to find areas and perimeters by outlining the squares with a rubber band around the pegs. For example, "give an area of four and a perimeter of eight." 11:10. Mrs. N asks the students to turn their boards over. There's a circle with 14 pegs on it. She asks that they make three different shapes with three rubber bands. Mrs. N discusses the students' shapes and the number of sides they have to each figure. 11:13. Mrs. M's (MPS) first group is finishing up their use of the trundle wheel. I watch Irma* for a minute. She holds the stick with the wheel on the floor. A piece of tape on the sheet designates one meter. As Irma* walks, the wheel rotates. In ten strides she walks 6.5 meters. Each student is asked to take ten strides. 11:16. The groups change. . . .

The MPS showed the children how to measure "meter" using the trundle wheel.

Day 8b (A, 10/28, p. 3)

. . .11:27. I stepped out in the hallway, and found the math project specialist explaining the trundle wheel to her second group that included Jeff, Deborah, etc. The students have completed the height measurements, and stand along the west wall holding their tape rolls. Mrs. M explains that one rotation of the wheel is one meter. She checks the measure by putting the measuring or meter stick on the floor and rolling the wheel alongside. She then asks the students to count the number of meters. 11:35. . . .

The aide left before the last rotation of the groups (the aide left at 11:30 everyday). Obie, a target child, was still having difficulty with distinguishing centimeters and meters.

Day 8c (A, 10/28, p. 4)

. . .Mrs. A tells her last group to go to the geoboards and make the shapes they learned at her center. They work independently. I ask they group if they are making their shapes in order, such as triangle, three sides; square, four sides, etc. "No," says Wanda. "We just make shapes." "But not in any order?" "No," she repeats. They are noisier without supervision. Mrs. A reprimands across the room. Because I have not taught or helped, I assume that is why the students do not recognized me as an authoritative figure. I do not care for that position either. 11:45. I go into the hallway. Mrs. M is watching the children finish up their height measurements. I noticed the children are grouped in threes. "Did you find three were needed?" I ask Mrs. M, as I notice one child against the wall and holding his tape, one holding the tape at the floor, and another marking at the head with the meter stick. She says, "there are only three meter sticks, so it made sense." A few tell me their height. Obie* says, "I'm 140." "140 what?" I ask (as Mrs. A has asked repeatedly in class). "Meters." "Meters or centimeters?" I ask. "Centimeters," says Obie*. 11:50. . . .

At the end of the period, plans for the next day were discussed.

Day 8d (A, 10/28, p. 5)

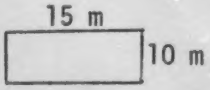
. . .Mrs. M and Mrs. A and I stay for a few minutes to discuss today's lesson and plans for tomorrow.

> Mrs. M has cut a square out of black plastic. She holds a jar of lima beans and discusses how both might be used for estimation tomorrow. It is also decided that Mrs. A will work with two-thirds of the class, and Mrs. M will have the remainder. We leave the classroom and meet the principal in the hallway. He says he observed Mrs. M and students in the hall earlier, and thought things looked great. We say goodbye to Mrs. A and head for our cars. . . .

Wednesday, the third day the MPS was in the room, the class was again divided into three groups. Mrs. M's group (the MPS) worked in the carpeted area of the room in activities lessons on area and estimation, the aide's group was at the art table working in workbooks followed by geo-boards and Mrs. A's group worked on Pages 24-26 of the textbook. An excerpt from the protocol indicates that some children were still confusing area and perimeter.

Day 9 (A, 10/29, pp. 1-4)

> . . .Mrs. A begins to give specific directions while holding the text, "come up with an approximate shape."
>
> Vic*: "Like with our foot?"
>
> Mrs. A: "Yes. First count the number of complete squares and put the number in the 'more than' blank, then in the 'less than' blank, what would you count?"
>
> Fred: "Everything."
>
> Mrs. A: "Right, after doing the three shapes on Page 24, make three shapes of your own. Now there is something on this page that I didn't show you. Cm^2 is the same as 'square centimeters'." (Mrs. A continues to explain directions for Pages 25 and 26. Looking at Page 26, she asks the class:)
>
> Mrs. A: "How do you find area?"
>
> Vic*: "Add."
>
> Teri: "Add two 10s and two 15s."
>
> Mrs. A repeats what Teri has said and adds, "yes, for perimeter, but how about area?"



Vic*: "Count the squares."

Mrs. A: "But there are no squares on your page."

Diane: "Multiply" (her answer is not heard)

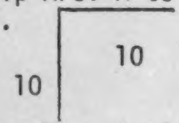
Mrs. A: "You could multiply. Ten times 15."

11:00. Mrs. A calls Betty, Irma*, Vic*, Carl, Fred, Roxanne* and Stephen to Mrs. M's (the MPS) group. The MPS has placed a black plastic square meter sheet on the carpeted area. The children and MPS sit around it. She first asks for the length of one side of the plastic.

Vic*: "One meter."

Mrs. M: "How big is this orange slab? It is one square decimeter."

She asks the group if they could tell how many slabs would be needed to cover the plastic. The children make several guesses and Mrs. M records them: 116, 400, 1600, etc. They help Mrs. M to cover one row length and one row width.



MPS: "As you learned from Mrs. A, length times width or ten times ten equals 100. It would take 100 of these to cover the whole thing."

Stephen: "The whole thing?"

MPS: "Yes, do you want to see if you can put them in?"

The children cover the plastic with all the available slabs.

MPS: "As I go across, you count by tens."

They count to 100.

MPS: "This is an example of an area that is ten by ten, or 100 square decimeters. Now will you stack these up?"

The students help to clear the plastic, and place the slabs on the circular table. The MPS is now holding a jar of lima beans.

MPS: "We'll play a 'let's pretend game.' We'll pretend this is Camp Cooper (pointing to the plastic). As we'll pretend these beans are cactus. Help me to sprinkle these around. Now stand back and sit on your hands." (Some children had tried to keep a few beans.) "The problem is how many cactus are on Camp Cooper? One way to find out is to count all the cactus. Another way is (she's holding a clear plastic decimeter slab) is to pretend this is a helicopter that flies and drops right here on these cactus. How many is it on top of?"

The students count the number of beans under the plastic plate and say, "seven."

MPS: "Yes, there are seven here, but how many all over?"

Students: "100."

MPS: "Seven times 100 equals 700. Now I'm going to use this penny as a Frisbee. I will throw the Frisbee into the desert. I'll place the plastic decimeter over it. Now we count how many are underneath. I want each of you to do this and record your answers on this sheet."

Each child in the group takes a turn. . . .

At Mrs. N's table and among the desks, students are making first a shape for each problem on the geo-board, and then drawing it on the dot ditto (which represents a large geo-board), and finally filling the blank on their page or paper. Mrs. A and Mrs. N are checking answers on the geo-boards before the students draw or record their answers. Those without geo-boards work on Page 24. I asked Mrs. N if the students were asked to come up and have their work checked before drawing and recording their answers. She said, "yes." And I asked if all the students were doing so. Mrs. N replied, "yes." 11:21. The groups change. . . .

Planning between the MPS and classroom teacher regarding the teacher's lesson plans for the next few days and the MPS's return the following Tuesday again occurred during lunchtime.

The next day, Thursday, Mrs. A gave a test on area and perimeter to the Grade 5 students from Scott, Foresman Test Number 3. Four students, including Irma (a target student), leave for band at 11:00 and do not return to complete their tests until 11:30. The band can be heard in the background. Towards the end of the testing period Vic, another target student, attempted to assist Carl with the test but was prevented from doing so by the aide who was supervising the test. Later he also tried to help others but was rebuffed. The "band" students finished their test very rapidly upon returning to the room so that they could join the other Grade 5 students at the art table and finish their Halloween masks.

Meanwhile, Mrs. A taught the Grade 4 group a lesson on converting centimeters to meters and meters to kilometers.

The ethnographic assistant arrived early on Monday and found that Mrs. A was very disappointed with the test results. That day they would review the concept of area and everyone would take the test over.

Day 11a (A, 11/3, p. 1)

> . . .I entered the classroom as the children were leaving for recess. Mrs. A did not have recess duty today, so we discussed the test the children took last Thursday. I asked how Carl and Vic* did, and told her how Vic* had interacted with Carl over the last two problems. She said no student made higher than a D, or made less that four mistakes out of ten. Carl had changed his last answer to 136, the same as Vic*'s, but how that answer was reached was beyond Mrs. A's comprehension. Therefore, the students were going to receive a review today, and take the test over again. Perhaps the holiday interfered with the performance. . . .

The review lesson which went from 10:45 to 11:35 included a review of the method of estimation of number of cacti in a larger area, e.g., a million meters, from one square meter, as observed in the MPS's lesson the previous week. The review also covered making a distinction between square and rectangle, a measurement activity with a string showing how to measure area and perimeter, and a reminder that area is width times length. The estimation activity with graph paper involved estimating the number of three different cacti denoted by three different colors for 100 square meters. One student, Barbara, left the room with an adult for the entire period and the usual group went to band. The lesson was interrupted by a fire drill also.

At 11:37 the teacher read each test question to the students and gave them 15 minutes to complete the test. At lunchtime the ethnographic assistant stayed to talk to Mrs. A about the test and found the teacher again very disappointed in the results.

Day 11b (A, 11/3, p 8)

> . . .I ask her how she felt when she looked at the second test papers coming in. "Terrible," she replied. She didn't believe there was any sign of improvement, and guessed she had gone as far as she could with them on this subject, or tried to teach them too much. "Perhaps area and perimeter should be taught separately," she said. I asked if she could remember how she felt the first day the MPS visited the classroom and worked with the children at their desks. Mrs. A said she was pleased with Mrs. M's interaction. She was also pleased with all the materials the MPS brought from the math lab and the instruction activities she carried out. I asked if she felt the aid that the MPS offered during her week out was needed? "Yes," said Mrs. A. If the MPS had not come she would had stuck to instructing with just the Powers of Ten Kit. All that the MPS suggested or did, brought creativity or expansion into the math lesson. One thing that did puzzle Mrs. A as she looked at the test booklets was that if she had stuck more to the books, the children would have been more prepared for the book test. But on the other hand, they learned so many interesting things from the MPS. She said that grades were already determined and that this test would not make a difference. . . .

Mrs. M selected another lesson in estimation to teach during her Tuesday visit to the classroom.

Day 12a (A, 11/4, pp. 1-3)

> . . .The children sit around the meter square with the MPS. She asks that they get their books for writing on. The MPS's first group includes Betty, Wanda, Vic*, Carol, Fred, Irma* and one other child. 10:55. Mrs. M has a container of three different kinds of beans, and scatters several on the sheet. She asks the children which beans are the largest. It is the lima bean. She says that they will vote on what the lima bean shall be called. She asks how many would like it to be a sahuaro or a barrel cactus. The barrel cactus wins, so under Sample Number 1 the children write barrel. Now she holds up a garbanzo bean and asks if it should be

called a prickly pear. The children agree and write prickly pear under barrel cactus. Finally she holds up a small bean and asks the students what they would like to call it. They say, "pincushion." After pincushion is spelt for them, Mrs. M takes out a penny from her purse. She asks the children into how many sections has she divided the sheet. The students reply, "four." 11:00. A male enters the classroom and asks for some papers on Roxanne*, who is absent today. Mrs. A talks with the man, and he leaves. Mrs. M tells each child to take a bean and put it by their words so they remember which bean represents which word on the handout. Wanda is the child to Mrs. M's right, and she tosses a penny into a square. First the lima beans are counted and the total comes to 25. Mrs. M asks the children, "who knows what four times 25 is?" Wanda says, "100." Mrs. M asks Wanda, "how did you know so fast?" Wanda says, "four quarters make one dollar." Mrs. M then says to find kilometers we'll multiply 100 times 10,000. 11:03. Mrs. A comes over to the MPS's group to observe. She has left the northside of the room, and the children are working independently. I notice there are four math problems on the chalkboard: (1) 931-14= ; (2) 79-48= ; (3) 100-21= ; (4) 319-280= . 11:04. Wanda has 18 prickly pear beans in the square. 11:05. Mrs. A leaves the MPS's group to see if students are checking their answers. 11:06. Wanda is counting the small beans or pincushions. Mrs. M tells the children there is only time for two more people to toss. She says to be fair she will think of a number between one and twenty. Each child except for Wanda takes a turn guessing the number. Her number was eight, so Irma*, who guessed ten, and Fred, who guessed six, got to toss the penny. Mrs. M and the group go through the same procedure beginning with Irma*'s toss. 11:09. . . .

During this time Mrs. A was supervising the other groups of students who are completing subtraction problems. Mrs. A used a manipulative aid in her explanations to students.

Day 12b (A, 11/4, p. 4)

. . .Mrs. A writes a new problem: (5) 1008-93= . Mrs. A asks those who finish to check their answer by putting back together what they took apart. At the board she writes:

```
1008
- 93
```

> She says, "when you have an answer check for the top number again. 11:18. She asks the children who thinks they have the answer right. She demonstrates the answer by using blocks from the Powers of Ten Kit. Holding the thousand cube, she says she takes it to the bank for a one hundred slab, but needs ten. She'll give one back and keep nine. . . .
>
> $$\begin{array}{r} 1008 \\ \underline{-\ 93} \\ \underline{915} \\ 1008 \end{array}$$

After the groups rotated, Mrs. A played "follow me" with the children. Mrs. A's next group also played games.

Day 12c (A, 11/4, p. 5)

> . . .Diane comes over to join the group and Mrs. A explains they're playing "follow me." 11:31. Again the students want the game to be harder. Mrs. A says, "start with $5.00; subtract $ .75; add $ .25 and subtract $1.00. Stop." First she calls on Teri who does not answer, next Henry who gives the wrong answer, and finally Teri who says, $3.50, and this is correct. Obie*, Irma*, and Vic* are in this "follow me" group, but Mrs. A has to call on Irma* for her to participate, and Obie* does not try at her desk or out loud to answer the problems. . . .

Followup at Camp Cooper: an Outdoor Mathematics Activity

The ethnographic assistant drove out to Camp Cooper Wednesday afternoon to observe the outdoor math lesson. The lesson began at 2:30, after a lesson on using a compass and after a break.

Day 13 (A, 11/5, pp. 3-4)

> . . .Mrs. A collects the cups afterward, and settles the children for their next activity. Mrs. A tells the children they are going to mark off a 100-meter area with string. She asks the children how many meters of string will be needed. Answers are thrown out, and soon one child says 40. Using a few children to help, forty meters of string are cut using the trundle wheel. Then the string, held by four children, is used to mark off a square of the desert. Following a procedure similar to classroom instruction, one child (Betty) throws the Frisbee into the square. A two-square meter area

> is marked off with the trundle wheel around the Frisbee. Three students (Vic*, Deborah and Diane) record the number of cacti and the multiplication figures. Two samples are carried out. The lesson ends about 3:30. Mrs. A had said earlier that she didn't expect much for this followup. She mentioned the students being restless, and still having difficulty determining perimeter and area. The students did not appear apathetic with the lesson, many wanted to throw the Frisbee for Sample Number 3. One helper (adult) commented that the lesson was fun. After gathering the materials together, Mrs. A called the children back to the ramada. She told me they were going on to something unrelated to math, so I left. . . .

Final Interview Following the Observation Period

The principal investigator, ethnographic assistant and classroom teacher met on December 9, after the observations were completed, to discuss the study. The teacher stated that the target students were not so different from the others in achievement and that there was one student not on the list who should have been selected. Mrs. A mentioned that she watched the children more who had been selected for observation.

Mrs. A said she had enjoyed having the MPS work in the classroom. She felt more positive about the MPS after working with her because the MPS was so flexible. It had been a relief to find that she, the classroom teacher, did not have to change her mathematics program to meet Title I project requirements. (Mrs. A was focusing on developing new strategies for teaching writing this year and didn't want to change her math program.) She hadn't gone to the last inservice but sent the aide as "the aide does more of these creative-type things anyway."

Mrs. A was disappointed in the students' failure to learn the manipulations necessary to pass the Scott, Foresman test on area and perimeter. She said that asking the students about area and perimeter would produce a groan. However, if they hadn't been tested on it and failed, perhaps they wouldn't have felt that way. She also wondered if the concept had been too difficult for the fourth graders. The teacher was concerned about student attitudes where students want to get their work finished but don't want to be bothered by understanding. She was also concerned that the students were not paying attention to the math lesson until after she assigned a specific page to complete, and she help them individually.

Mrs. A mentioned that she had consciously adopted a teaching style that allowed students to respond in unison, perhaps as a cultural adaptation. She felt her students were quickly calmed down and therefore a teacher can permit the class to be closer to noncontrol.

Summary

This case study describes a situation where the classroom teacher changed her classroom organization and regular teaching methods in an attempt to implement an approach using visual representations through the use of graph paper, etc., in teaching measurement concepts. Despite the provision of activities, the mathematics lessons still contained a large amount of time spent in teacher chalkboard demonstrations and whole group recitation instruction. Numerous requests by individual students for assistance following these group lessons suggested that these whole group lessons were less than efficient. However, sometimes students were observed asking for individual attention when it appeared they knew how to perform the activity independently, e.g. as observed in Vic*'s behavior. Also another target student, Obie*, was observed requesting the identical help from the teacher right after she had received ample help from the aide (A, 10/27, p. 2). This phenomenon was also observed by Gumperz (1981, p. 19) and interpreted as minority children's play for company:

> . . .We began to hit upon a solution when we examined tape-recorded instances of children responding with sentences like
>
> I don't know.
> I can't read.
> I don't want to do this.
> I can't do this.
>
> All such sentences were pronounced with similar intonational contours, characterized by high pitch register, sustained tone, and vowel elongation on the last syllable. We then played recorded samples to a group of Black judges and asked whether they thought the child in question really didn't know or didn't want to cooperate. The judges agreed in saying what the children really mean to say in these cases, "Help me; I don't like to work alone." They denied that such statements implied inability to perform, even though we told them that this is how white judges are likely to interpret them. Once we became aware of the special communicative import of the children's intonation contour, we began to see more and more evidence that the children really were asking for company rather than signaling lack of ability. One child

> who had asked for and received help from the aid actually said, when she started to leave again, "Don't go away, I'm going to need some more help in a minute."
>
> A few months later, one of the Black children who had been most persistent in asking for help called the researcher over to show her that he had finally mastered some addition and subtraction tasks which he had been trying to understand for some time. She looked over his work and said: "Perfect." Whereupon he commented, "I could do them by myself now." "I am going to show it to Mrs. P. (the aide) also." When the researcher turned away, the head teacher, Mrs. J., walked by. The child looked at her and said, using the intonation contour previously referred to, "Mrs. J., I can't do this." The teacher stopped, turned to him, and once more went over the correct procedure with him, telling him, "you ought to be able to learn this." When the researcher, who had watched the scene with amazement, asked the child why he had called the teacher, the child answered with a smile and said, "I decided it was about time for a quick trick."

Classroom lessons also emphasized the terminology of the metric system, adding further complexity to the content. The services of the Mathematics Resource Teacher were used to provide additional manipulative activities in the measurement unit to groups of students (the class was divided into groups especially to facilitate coordination between classroom teacher and Mathematics Specialist). However no special attempt was made to have the mathematics specialist demonstrate methods of teaching area and perimeter. These later appeared to be the central concern of the teacher as expressed in her disappointment in students' poor performance on a textbook test of problems involving area and perimeter. In the teacher's view student performance of this test rather than their application of measurement concepts in outdoor activities at Camp Cooper constituted the actual follow-up of the unit. The teacher equated the failure of student's to perform on the test as a failure of the activities approach as an effective teaching method.

Although manipulative aids, e.g., concrete objects in the Powers of Ten Kit and graph paper, were used in demonstrating the concept of area and perimeter, and students were also given these aids to use in their assignments, much emphasis was placed on students producing right answers rather than upon strategies students could use to "prove to themselves" that their answers were correct (in contrast to the use of pattern blocks in teaching fractional equivalency in Study F). The much used analogy of the fleas of a dog to the area may not have been clear to the students and the dog analogy may have been culturally inappropriate to Yaqui students (as dogs are not considered pets in traditional Indian culture). (Students had object~~iv~~ed to using the term "dog" house earlier as a discipline technique.) There were numerous instances in the protocols of low achieving students not being quite sure of the relationship between the graph paper diagrams and formulaic algorithms for getting the answers to symbolic problems, long before the posttest. Admittedly, the evidence for this was in student requests for help to teacher and aide which, as mentioned above, may not always have been cognitively motivated. However, since little emphasis was placed upon teaching students the technology of the manipulatives used in instruction, students may have been genuinely uncertain about how the spatial concepts related to the symbolic level. Perhaps more coordinated lessons directly relating problem solving with manipulatives at the concrete and representational level to problems stated symbolically would have served to improve student understanding.

Reference

Gumperz, John J. "Conversational Inference and Classroom Learning," Ethnography and Language in Educational Settings. Judith Green and Cynthia Wallat (eds.), Ablex Publishing Corporation: Norwood, New Jersey, 1981, pp. 3-24,

Study A

Observation Schedule

Date	Day	Hours	Minutes
10/6/80	Mon.	1	14
10/8/80	Wed.	1	15
10/17/80	Fri.	1	15
10/20/80	Mon.	1	16
10/21/80	Tues.	1	16
10/22/80	Wed.	1	14
10/27/80	Mon.	1	19
10/28/80	Tues.	1	13
10/29/80	Wed.	1	14
10/30/80	Thurs.		50
11/3/80	Mon.	1	16
11/4/80	Tues.	1	16
11/5/80	Wed.	3	

TOTAL - Days: 13 Hours: 17 Minutes: 38

Classroom Ethnography Case Study
for Research Site B/C

Context of the Research Setting

This research site involved two teachers who were team teaching a combination Grade 2 and 3 group of students in two adjacent classrooms. The mathematics instructional period was from 12:15 to 1:15 daily. Mrs. Smith, the third grade teacher taught a group of 17 students, including a few of the higher achieving Grade 2 students. Mrs. Bell, the second grade teacher, taught a group of 18 second grade students. In the morning (which was not observed in the study) several adaptive education students were mainstreamed into the group. The morning instruction consisted of reading, taught by the teachers, and various centers, including math, supervised by two aides.

This was the first year that they were implementing the Title I mathematics program. They were using a classroom organizational plan that had been presented by an outside mathematics consultant at a Title I workshop the previous spring. The teachers had attended Title I math workshops the previous year and had received informal help from the Title I Math Project Specialist (MPS) but this was the first year they were to receive direct services for students. Both teachers had been dissatisfied with their previous mathematics program and thought the manipulative-concept development approach to math and team-teaching might be better. They had spent the summer planning the new program.

This case study describes the classroom implementation of the Title I Mathematics Resources Project in two classrooms over a period of five weeks from October through the beginning of November. A brief followup study was done in the spring. The protocols indicate that every manipulative and math game presented in the Title I mathematics inservices were used in at least one of the classrooms. Also the grouping plan, interpreted as an instructional cycle of (1) teacher-guided small-group instruction, (2) followup worksheets and (3) independent centers using games, were used to organize instruction around basic concepts and skills rather than following a textbook orientation.

The students in the classrooms came from a variety of ethnic and national backgrounds. Student language backgrounds included Persian, Laotian, Vietnamese, Spanish, Indian, Ecuadorian, and Chinese, as well as English. Most students spoke English but many counted in the home language. Students sometimes acted as interpreters for their parents during parent-teacher conferences. In the classroom everyone, including teachers, aides and students and the ethnographic assistant were on a first name basis.

Organization of this Report

All names are fictitious and do not reflect ethnicity. Title I participants are designated by an asterisk before their name.

Since this was a team-teaching arrangement, observations from both classrooms will be given. Observations referring to the Grade 2 group taught by Mrs. Bell will be designated by the letter B followed by the date of observation and protocol page number. The same procedure will be used to reference observations of Mrs. Smith's Grade 2-3 group which will be designated by the letter C.

Pertinent names are:

Mrs. Smith:	Classroom Teacher C, Grades 2-3
Mrs. Bell:	Classroom Teacher B, Grade 2
Mrs. Jones:	Mathematics Project Specialist (MPS)
Mrs. Wing:	MPS
Mrs. See:	MPS

Larry, Ann, Alice, Sally, Mike, Helen, Mary and Ken were considered low achievers in math.

First Observations: A New Mathematics Program in the Process of Being Implemented

The protocol from the second observation day shows that both teachers are using grouping for mathematics and both followed a basic instructional cycle of instruction, followup and math game. The Title I aide assisted in the Grade 2 classroom; the Grade 3 teacher was unassisted. Diagrams of the classrooms' arrangements are found in Appendix C.

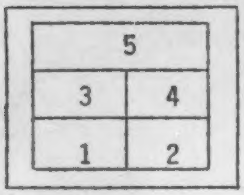
Day 2a. Mrs. Bell's Classroom: Grade 2

> . . .At 12:15 the buzzer of the clock rang and students began to change to proper groups and room. Each group has a student leader and that leader is expected to keep their group in control and to get the materials needed for their group. In Mrs. Bell's classroom there were three groups: (1) teacher-instructed table, (2) aide working with a group working the computer game and (3) working independently. The teacher-instructed group with five children were working on place value. The materials being used were three egg cartons, pieces of paper with Ones, Tens and Hundreds

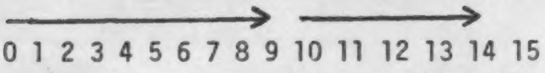
written on them, and toothpicks and rubber bands. The students had their materials in front of them. The teacher gave each child a bundle and asked them to count them while the group looked on. Then the student put his toothpicks in the appropriate places to show its place value plus read his number out loud. The group working independently were also using a computer card made from various colors of construction paper with a plastic coating. On the paper were drawn lines to house from left to right: blocks (1000s), flats (100s), longs (tens) and units (ones). The students were using an addition tape, My Computer card, and pencil. These students were counting to 500 by placing one unit at a time under the heading Units and writing that number on their addition tape or roll until 500 was reached. The aide was working with another group of five students on the My Computer cards in a game form. Allowing each student a turn throwing two dice, whatever numbers turned up, the student built that number. Example: a 21 was thrown, the student put one unit and two longs on his computer card. If he got it correct, the aide had the group clap softly. The aide was giving directions in English and Spanish for those needing it. At 12:30 I changed rooms and entered Mrs. Smith's room. (B, 10/16, pp. 1-2)

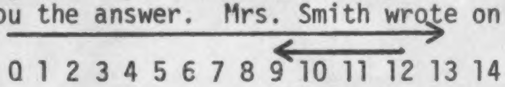
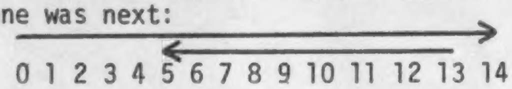
Day 2b. Mrs. Smith's Classroom: Ungraded Three-Two

. . .Mrs. Smith's room was also organized into three groups. Mrs. Smith called a new group to her at 12:42 to her instruction table. Each group also had a student leader. The leader at the table was Mrs. See and she was expected to keep order. Today Mrs. Smith wanted to teach a new game to the game group so she asked Mrs. See's group to figure out 3 + 4 + __ = 16, 6 + __ = 17 while she was gone to the game group. At 12:46 Mrs. Smith asked the game group to meet her on the tan rug. There she taught quickly a beanbag game. A cardboard which was oak tag was designed like this:



Each student was given three beanbags to throw and hopefully all three landed on the areas given points. Then all three numbers were added together to give a score. Each student had his name written by himself on the blackboard to keep his own score. There were four children in this group *Sally (Laotian), *Helen (English), *Ken (Chinese) and Rita (U.S.). The one with the highest amount of points at the end of math-time was the winner. The four students tended to get noisy with excitement! The encouragement this group gives *Ken was almost like treating him like a baby. He hadn't made any points after several turns. They told him he would do better with practice and even after a few throws allowed him to move up and take his shots from a shorter distance. He finally made three points and the group was wild with excitement for him. The independent group had left the instructional table at 12:42 and was given the following math pages stapled together, pp. 32, 33, 42, and 43. This group could sit anywhere to do their work. I noticed two boys sitting together on the beanbags near the rug area. The beanbags were sitting on a lime-gold colored shag rug. These boys were sharing ideas on how to do their math pages. These pages came from their textbook. Several other students sat at tables to do their work. 12:50. Mrs. Smith was back at the table and opened her black notebook. She explained to this group that they were going to review adding three numbers together. "Before we do these," pointing to the equations written on the board, "we are going to review the number line." One student commented on how fast the teacher could write as the teacher put the number line on the board with chalk. Mrs. Smith answered the student by saying, "I have been writing a good long time and when you have been around as long as I have, you will write fast too." She continued to explain the number line, "if you find arrows like these,"



> "what would these arrows mean?" One student said, "9 + 5 = 14." Mrs. Smith asked the group to do another. One student was not watching and was talking so Mrs. Smith made the comment, "Do you think you ought to pay attention?" Everyone was watching closely. Carol excitedly said that it told you the answer. Mrs. Smith wrote on the board:
>
> 
>
>
> The group did this together as the teacher pointed to the arrows. The group answered, "13 - 4 = 9." Mrs. Smith, "is 9 where the arrow ends?" This one was next:
>
> 
>
>
> Mrs. Smith had the group count the number of the arrows as there was some difficulty in understanding the arrows. First, counted the numbers of the arrows going and then wrote that number first and then counted the numbers of the arrow going and wrote that number forming the equation: 14 - 9. The group gave the answers, "5." At 1:05 Mrs. Smith returned to the equations on the board: 3 + 4 __ = 16, 6 + __ + 2 = 17. One student gave 9 as the missing addend to the next equation. Mrs. Smith was delighted. 1:07 and it was cleanup time and time to sit on the tan rug. "You did beautifully today! Do you find it getting easier?" The group answered, "yes.". . . (C, 1/16, pp. 3-5)

The two teachers attended a mathematics workshop on using manipulatives in the instructional process to teach numeration, place value and addition, on October 21. While the workshop included games and specific directions about using worksheets with manipulatives, it also stressed the need for a strategy for teaching the use of manipulatives themselves, which included learning what the rods represented--itself a kind of technology. Teachers practiced doing activities that later they would be asking children to do.

Day 3: Math Workshop

> . . .Mrs. Wing (MPS), our leader, had the kit and worksheet papers and cuisenaire rods ready for

> us to begin work. We started by making rod pictures to get us used to size and color of the rods. Then we turned our worksheet page and did an activity matching rods and numerals which was a more directed activity. Here Mrs. Wing (MPS) explained that the signs > and < could be introduced and used. We played the game, Playing the Comparing Game. We did Worksheet 22 as a group only doing 1, 2 and 3 to get the idea as we were being rushed for time as they wanted to cover many games and materials before time to leave. I'm Going _______ was lots of fun! On Worksheet 26 we did activity Number 2 then Mrs. Wing (MPS) explained how all the other names for 6 using two addends could apply here by writing the math sentences. She also showed the staircase values and pattern of 5, 4, 3, 2, 1 and 1, 2, 3, 4, 5. Quickly went over Worksheet 38, communicative principal. On Worksheet 40 we got into number names with the color of the rods. We then played another game, Playing Challenge Match for Addens (81). Mrs. Wing showed us how to build 3 + 5 = 8 using rods. Commented how students could make their own number stories on Worksheet 49. We skipped Worksheet 50. It was explained how important it was to lift the rods up so the students could find the missing addend as in the example on Worksheet 73. . . .
>
> . . .This time worked with Power of Tens Kits. About 10:35 we were asked to build 3 tens, 6 ones, which we did. Mrs. Wing (MPS) took us through trading and identified the pieces as block (1000), flat (100), long (10) and unit (ones). "In order to fully understand place value concept using Power of Tens you should look at it, build it, write it, and say it.". . . (B/C, 10/21, pp. 2-4)

Later that day, use of manipulatives for developing a counting model of numeration was observed in the second grade room. Mrs. Bell explained that the counting/place value activity using toothpicks and egg cartons used 10,000 toothpicks. One of the students explained the activity to the ethnographic assistant.

Day 3: Classroom B

> . . .There were three egg cartons with ten pockets instead of 12. The small pieces of paper had

> ones, tens, hundreds written on each to put in front of the egg cartons. One toothpick at a time was placed in each pocket of the egg carton. When one toothpick was placed, then the student wrote that number on his paper. When all ten pockets of the ones were filled, they were bundled in a bunch with a rubber band and placed in a pocket in the ten's egg carton. This was done until 1,000 had been reached. Ted was proud and excited as he explained this process to me. . . (B, 10/21, p. 5)

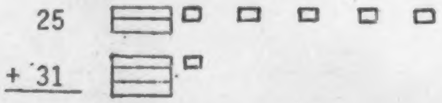
One of our original research questions was to determine how children were helped to translate concepts understood using manipulatives to symbolic representation. In Classroom C, Mrs. Smith often used worksheets helping children to do this within the context of the teacher-guided small-group instruction and the followup independent worksheet activity. In this way, students were exposed to three models of numeration, the counting model, the measurement model and the symbolic model.

Day 4a. . . .Mrs. Smith said that we were going to do something different today. We were going to be adding two numbers! The Ten Blocks were located in the middle of the table. Mrs. Smith asked *Ken to make the number 25 using the Ten Blocks. While *Ken was doing that, Mrs. Smith asked Rita to make us the number 31, which she did. "If we want to add 25 to 31, how would we do it?" It was 12:34 and *Ken said, "you put them together." Mrs. Smith wrote on the board:

$$\begin{array}{r} 25 \\ +\ 31 \\ \hline 56 \end{array}$$

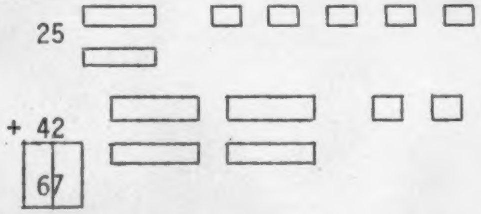
tens ones

Now she added the longs and units:

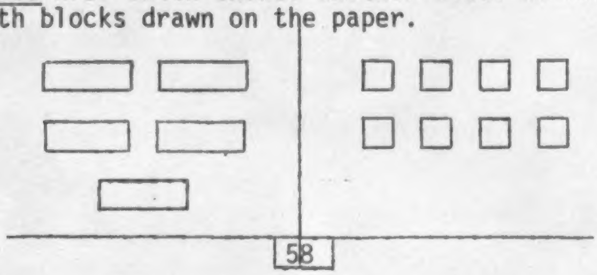


The group watched *Ken and Rita put their Ten Blocks together and counted as a group.
Mrs. Smith had Lee make 46 and Chuck make 22 which they did correctly. Lee was asked to put them together. He did so like this:
4 tens + 2 tens = 60   6 + 2 = 8, so we had 68.

Mrs. Smith reminded the class gently that we started at the left for reading and started at the right when doing math, that way it made them even. Mrs. Smith continued, "let me give each of you a practice paper." Chuck and Rita were asked to go to the cabinet and get more blocks, but *Ken went with Rita instead. Chuck made a comment to Mrs. Smith, "you said Chuck." Mrs. Smith answered, "that's okay." Everyone was ready to work. Mrs. Smith said, "this paper you don't have to turn in to me. Draw a picture of 25 using tens and ones." Chuck asked if they could do it sideways. Mrs. Smith answered, "any way you like - just so you know what it is." Mrs. Smith asked the group, "can you make that number with blocks?" Group answered, "yes." "Then place them aside the picture." The worksheet looked like this:



At 12:40 the group was asked to draw picture 14. Chuck made his comment heard, "oh, no! You have to draw 14 of these" (longs). Toby said, "No! You just need a long and four of these" (units). Mrs. Smith had the group build Number 14. This time one person got 34 as an answer and another 39 and Rita forgot to trade in her 10 units, but still got the same answer. Mrs. Smith had the group look on as she had Rita count and show how she did the problem and 39 was correct. At 12:45 Mrs. Smith showed another ditto worksheet with blocks drawn on the paper.



The group did these two problems and one example at the instruction table. . .
(C, 10/22, pp. 3-4)

Another important facet of this study was group management in which the one classroom without extra adult help stood out in contrast to the classroom with the aide. Students required a great deal of guidance in using manipulatives. Even in that classroom, the aide sometimes moved from group to group to supervise the children's activities and to provide individual help to students in accomplishing the task.

Day 5a. Classroom B: Mrs. Bell

> . . .The buzzer rang at 12:15 and students went to their math groups. Kathy's group was playing Spin A Flat at the game table. They were throwing the two dice and making or building that number on their computer card. The person with the most at the end of math time was the winner. Toi's group was counting using My Computer card, adding tape, Ten Blocks and pencil showing place value. At 12:21 Mrs. Bell passed out paper with squares that the students had been working on. They were using three egg cartons with ten pockets, toothpicks, rubber bands, pencil and their grid paper. At 12:25 Mrs. Bell helped Tim--he had one toothpick (unit) in each pocket of egg carton and needed to bundle his ten toothpicks to put in the ten's carton. He had trouble with the rubber band. Mrs. Bell asked Greg what he was doing with his toothpicks. He now had his last set of tens to another 100 giving him 300. He was using a grid with small squares. At 12:28 Mrs. Bell says, "When Greg reaches 1000 we are going to have a party!" Ted asks excitedly, "are we really going to have a party?" Mrs. Bell, "yes." Ted started a conversation about someone named Debby. Mrs. Bell said that she thought Ted had met Debby. She was going to be doing her student teaching here in January. She had blonde hair and the teacher pointed down to her shoulders. At 12:30 Mrs. Bell got up from her instruction table to quiet down the game table. The students wanted to go to 200 or more using three dice and flats. Mrs. Bell said she would like them to play for one flat (100). Now at the instruction table, the students did have a difficult time using the regular size rubber bands. Mrs. Bell was back to the instructional table where students were busy and excited. At 12:33 Mrs. Bell, from her chair said, "much nicer boys and girls." Then they explained what they were

> doing and Mrs. Bell approved. The aide was helping Bob count in Spanish. He was doing the computer game. The aide was moving from the game table to the counting table and back again. This way she could help Bob and also assist the place value concept at the counting table. At the instruction table, Kim was the first person at this table to reach new paper with bigger squares. She found it much easier to write her numbers. At 12:36 John was asked by Mrs. Bell to remove himself from the game table and was placed at an extra table by the tall cabinets in the back of the room. Mrs. Bell had to go get him in order to get him to sit at that table by himself. At 1:38 John had moved his chair closer to the game table and was helping with the game by telling whose turn it was and what they threw on the two dice in a normal voice. In the meantime, Tim had reached 200 and was ready for new big-square paper. At 1:40 Mrs. Bell called to John from the instructional table, "I didn't pull you out of the game to talk, so please sit quietly." Del was on 103 at the computer table using the addition roll. At 1:46 the game table was working nicely. . . (B, 10/23, pp. 1-3)

A primary focus of this case study is the interaction of children in the various kinds of groups, especially in Classroom C, where there was only one adult present, the teacher. We noticed a marked difference between groups that were teacher directed, and game groups that were managed in the peer group.

For instance, when a volunteer father was present in the room, he took charge of the game.

Day 4b. . . .*Mike's group had a brand new game. He had four in his group. Mrs. Smith showed cards with instructions and was called One Up. The person who started had to have a red 1 and the next card should be a red 2 or they must pass. You took turns around the circle of four students and the leader. Only one card each turn and when all cards were gone that person was the winner. Mr. B dealt and took charge of this group. . . (C, 10/22, p. 1)

In contrast, the next day students were playing a game which was peer managed in Classroom C, Mrs. Smith's room.

Day 5b. . . .I changed rooms and was in Mrs. Smith's room. Chuck's group was meeting with Mrs. Smith at the instructional table. Larry's group was working independently at different tables around the room. Mike's group was playing Two Up. Two Up was a card game in which you move by twos instead of ones (2, 4, 6. . .30). At 1:55 this group was enjoying the cards. These pink cards were handed out at Tuesday's workshop and Mrs. Smith made Two Up. Mike was very proud that he had 14 as his first play in the game. Carol liked to tell everyone in her group how to count by twos and also which direction the game should be going in order to keep the game moving. Carol told the group that they should be moving clockwise so everyone had a turn. *Mary loudly said, "waiting for a 6," as she wanted the person with the 6 to play next so little time was lost in between plays. *Helen said, "come on," to Carol. *Helen asked, "you pass?" "No," Carol answers and plays her card. *Mary put the cover card down for her turn and laughed. Now *Mary and Carol had the giggles. *Mike wanted to know if they were playing for pennies or something. At 1:03 *Mary had the red 20 which was badly needed for the other students to play. Carol loudly asked, "who has the red 20?" After a second time Carol asked, *Mary finally put it down. *Mary said, as the game was ending, "I had number 30, Toilet Face," and laughs. *Mike said, "I don't want to play around." Carol sang a song in a low, deep voice. Another girl, *Alice, joined this group on the tan rug. She began by holding her nose and talking in a singing-type voice. Mary shouts, "pass." *Mike was nudged by *Helen to play, which he did. At 1:03 *Mary won and *Mike acted like he was crying while lying on his stomach on the rug. Helen said she didn't want to play. I asked *Helen what she would do if she didn't play. Her answer was that she didn't have to play more than once. I asked my question again. She said she would play. At 1:10 *Mary left and moved on to see *Larry's group play a card game on the lime-gold rug called One Up. One Up went like Two Up. Shuffled and dealt out all the cards. Player with a red 1 started by placing it in the middle of the table or floor. The next player must place a red 2 on the top of the red 1 or place another 1 of another color in the center. Each of the players played in a similar manner

> until all his cards were gone. . . (C, 10/23, pp. 3-5)

On the following day, a pattern emerged which suggested that the game activity could not hold the students' interest for the period of time required for the other groups, i.e., the teacher-guided instructional group and the independent group, to complete their activities. In other words, children had only a short-term interest in the game and after playing it through once began to focus on the interpersonal dynamics of the group situation.

Day 6a. . . .*Larry's group was on the rug to play Two Up. This game was played like One Up but you counted by twos instead of ones. . . .

> . . .Mrs. Smith reminded the Two Up group that yesterday's group was pretty noisy and could they be a little more quiet today. There were four in this group. Today the directions were written on the Two Up cover card (pink with green ink). At 12:27 *Sally wanted everyone to count their cards and everyone did. I was watching the game group when Rita came to me and asked me to stop Toby from following her. I did nothing while Rita was going from table to table with Toby following her. At 12:28 Rita went to Mrs. Smith about her problem. Mrs. Smith asks Toby and Rita to sit down and do their work. Toby was sitting at the table in the back, in front of the instructional table, by himself. Rita sat in the corner near the window and the orange beanbag. The Two Up group was playing the game and enjoying it. . . .
>
> . . .12:45. *Ann and *Alice came to Mrs. Smith as *Ann told on *Alice for calling *Sally names and also saying bad words, while *Alice denied this. *Alice almost tore a playing card as well, according to *Ann. *Alice was asked to put her head down at a table which she did. . . (C, 10/24, pp. 2, 3, 5)

A protocol from the next week tended to substantiate the hypothesis that the game activity did not hold the interest of second and third grade students for a half hour without a direct adult presence. This appeared to be due as much to the social demands of the game activity--demands of conflict resolution, abiding by rules, fair treatment of others, negotiating first turn, etc., as it was from any mathematics/cognitive demands placed upon the students.

The following excerpt shows increasing intragroup conflict as the game progresses and its easy resolution by the classroom teacher when the group rotated to the instructional table. It should be noted that this kind of conflict was observed in fifth grade groups, e.g., Study E, but more quickly resolved, suggesting that younger children have not yet developed the personality skills to readily handle the competitive situation of the games on a peer-managed basis. Also, as suggested in Study H and Classroom B protocols, children often benefit from adult assistance (supplied by aides, volunteers, resource teachers) within the process of using games for learning concepts or skills not yet completely mastered.

Day 8: Episode One: The Game Group

> . . ._12:22_. The teacher gave directions to the children, who were sitting on the rug, to form the usual three instructional groups with one group going to one _corner_ of the room to the table to await the teacher for direct instruction and another group being given directions for completing a series of _worksheets_ and told to find places (either at tables or in the beanbag chair area) outside the rug area to complete the worksheets. One child asked if the worksheets could be done in any order and the teacher replied, "yes."
>
> _The Game Group_: These observations are focused on a third group, the "game" group of six children who were sitting behind the room-divider shelf on the rug. The observer sat on the side table which was not being used by students and which permitted a good view of the whole room. The teacher explained the game of Zooks to the group of children on the rug. The teacher, sitting (or kneeling) on the rug, showed the children a pack of cards and said, "these cards have numbers on them, if you see any two that add up ten you say Zooks and you get the cards and set them aside. Play the game through." The teacher then went over to the opposite end of the room to the guided instruction table, and the children began to organize themselves for playing the game. One child, Rita, assumed the role of

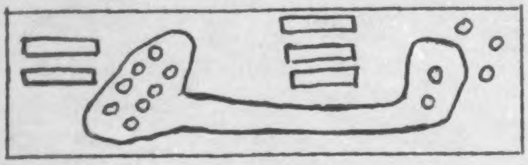
dealer and informal leader of the group. She began acting out by talking loudly and clowning, saying such things as, "I don't know why I deal out all those cards." Another child said shussh to her, and there is a general group discussion about how many cards did each one get. Then the children discussed the direction of turn taking, using gestures to indicate clockwise or counterclockwise. Rita finally said, "okay go," and the children started playing, with the exception of one child who laid down. All tend to call Zooks at once and there is much discussion about who really said Zooks first (thus winning) and if the numbers really add to ten (sometimes the group detected math errors, sometimes not). Opal defended her claim by saying that there were two cards with 2 and one of 6 so she should get everyone's cards at that turn. The children allow this (perhaps not remembering the directions of using only two cards or else preferring their own rules). As the children take turns, more heated argument continues about who wins until finally Opal said, "all right, you cheat, I'm not playing." . . . (C, 10/28, pp. 2-3)

Day 8: Episode Two: The Teacher-Guided Instructional Group

. . . The teacher immediately got Jack involved in the lesson by sitting him next to Roger and having them work out an adding exercise in which Jack has longs and units comprising 36 and Roger has longs and units equaling 27 and together they exchange units of 10 or more for longs to work out the answer. The teacher during this process, reprimands Rita for acting out, saying, "Rita, would you like to go out to the hall?" Rita sits up.

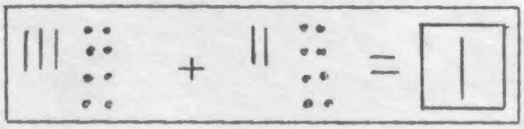
The teacher continues this lesson alternating pairs of children to work out the problems with the Powers of Ten materials. The teacher asks the children what number is made by combining the two numbers, drawing an illustration on the board and showing children how to mark off 10s like this:

BOARD



> Then the teacher explained the following representation which is similar to the worksheet:

BOARD



> The teacher asks the children, "how many longs, how many shorts?" Children in the group are attentive and responding appropriately to the teacher. . . (C, 10/28, pp. 5-6)

Classroom Dimension of Mathematics Resource Specialist Services

The math resource teacher had been asked to also concentrate services in the Grade 3 classroom but to also provide some help in the Grade 2 classroom, as time allowed, in order to support the team-teaching context previously in operation. However, the plan had been changed due to the unexpected absence of the Grade 2 teacher and her replacement by a substitute. The math resource teacher now planned to work fulltime in the Grade 2 classroom for two days and one day in the Grade 2-3 classroom.

While in the classroom, the MPS worked with two game groups, demonstrating the use of manipulative aids in the ten based place value system and emphasizing the orderly, rule-governed nature of mathematics game playing. Students were observed verbalizing and setting rules with the MPS and appeared very involved in trying to win the game. The MPS, Mrs. Jones, acted as the group leader and took the "banker" role in the game.

Day 7. . . .The banker was Mrs. Jones (MPS) and she had the bucket with the units and also the longs in front of her. Mrs. Jones handed Toi the die and Toi threw one die and got a 1. Toi asked for one unit and placed it under the Units on the computer card. Mrs. Jones asked, "why do you put it under the Units?" One student answered that it was 1 unit. Mrs. Jones, "is it a rule?" Donna answered, "yes." Mrs. Jones said she had a rule, "only the banker handled the units and longs. It is very important for the banker to see your computer at all times, so I know how much each of you has.". . . .

> . . .Each time a trade was made, Mrs. Jones (MPS) had the group count or measure before giving a long. This time it wasn't done by the group but

by Mrs. Jones. Mrs. Jones explained, "sometimes you don't have to count and you can measure." Mrs. Jones talked to the group, "Pat, I like the way you are sitting on your chair." "It's not a chair. It's a box." Mrs. Jones now reminded the group in a whisper she heard someone shssh a group, so we should keep our voices down. "Will you please help me remember that? I can only give people the die who are sitting in a chair and are ready." Mrs. Jones asked the group, "would you be happy today if we played till 3 longs?" The group answered, "yes." Joan and Pat had units in the Longs column. Mrs. Jones called it to the attention of the group by saying, "I thought there was a rule that units and longs couldn't be in the same column." It was agreed by the group that units should be kept in the Units and longs under the Longs. . . .

. . .It was Pat's turn and she was at the bathroom so she was skipped for this turn. When it came to Pat's turn again, Pat was present. Mrs. Jones, (MPS): "I have a problem and I need your help to solve it." Mrs. Jones continued, "Pat was in the bathroom and missed her turn. Do you think you should let Pat have two turns?" The group said, "no!" Mrs. Jones asked Pat if she thought she should get two turns. "Yes," said Pat. Mrs. Jones tried again to explain the situation. The group saw what Mrs. Jones meant and agreed to the rule: you should have two turns, (1) roll the die for while you were in the bathroom and (2) now roll the die for your turn. Mrs. Jones said that we should try to go to the bathroom during others' turns so we don't have to take two turns and extra time. Most of the children during this time were not really able to understand why Pat was receiving two turns and they weren't. Some considered this cheating. However, Mrs. Jones explained until the group did understand. . . .

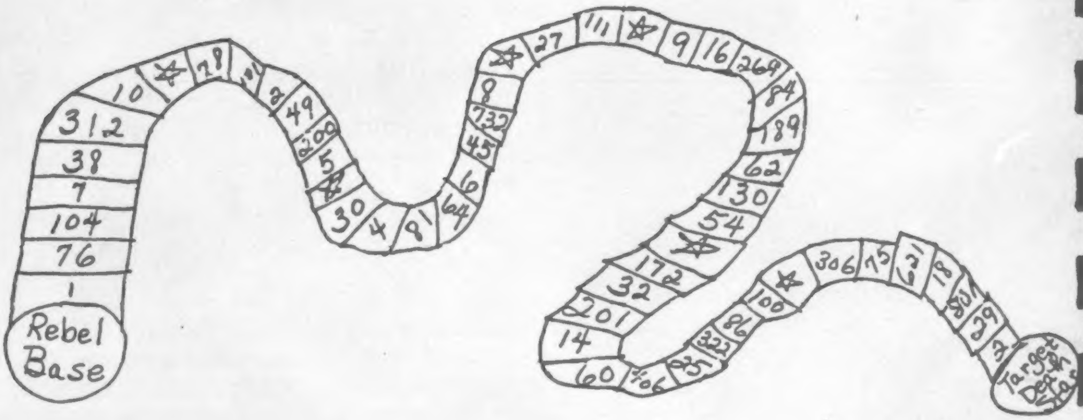
. . .At 12:48 the groups changed quietly and smoothly. At 12:52 everyone was ready at our table. We went through introductions as Mrs. Jones (MPS) needed to know their names and learn them quickly. The students in this group were Tim, Laurie, Ted, Kim, Greg and Cherryl. Mrs. Jones announced that she would be the banker. She explained the rules to this group as she did the last group (3 longs was the winner and

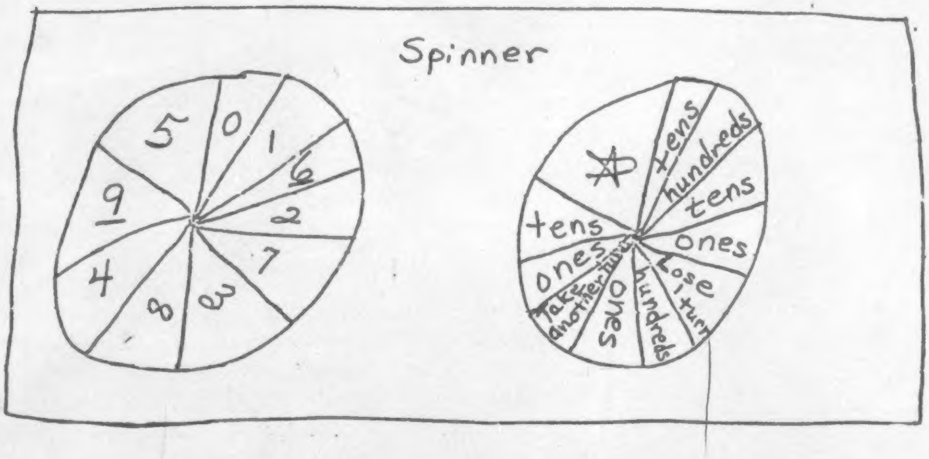
> 10 units were needed to get a long). "We will start with Tim." Tim rolled the one die. He proudly took his units from Mrs. Jones (MPS). "Rule Number One--only units in the Units column and longs in the Longs column. Be sure to keep the computer all straight. Rule Number Two--nobody can touch another person's computer." These rules were given by Mrs. Jones. "Okay throw the die, Laurie." A 5 was thrown. Laurie asked for 5 units and placed them on her computer under Units. Each person waited patiently for his turn and held out his hand for the die or his units. Tim rolled a 3 and was asked by the banker if he was able to make a trade as yet? "No," said Jesse. When it came to Greg's turn, he rolled an 8 and was asked by Mrs. Jones if he had enough for a trade. The group was shouting with excitement. Two was what Greg needed to make 10. Mrs. Jones, "someone was asking me a question. Please, everyone, be quiet." Tim now had 12 units with this turn and was asked if he could make a trade. Mrs. Jones was not sure if Tim could make a trade. She asked Tim, "can you?" "Yes," said Tim and he counted 10 units. In the meantime, Ted said loudly, "Jesse needs two more to make a trade." The group was reminded to keep their hands on their own computer. . . (B, 10/27, pp. 2, 3, 4-5, 5-6)

Observations After the Resource Teacher Has Been in the Classrooms

On Observation Day Ten, the first Monday in November, Mrs. Bell introduced a new board game involving recognition of ones, tens and hundreds, to the whole group. There are two identical games, each one to be played by two students. The aide helped the children get started playing the game. The children appeared to understand and enjoy the game, but sometimes needed help in reading the "Force Cards," which were a part of the game.

Day 10. . . .Mrs. Bell explained the game of where to start and where to end to achieve a winner. You spin the spinning wheel and where the tongue depressor points, you read that number. Then you have to spin the other spinner to know where to move or not move. She demonstrates: 3 hundreds, so Mrs. Bell looks for a number on the game board that has 3 in the hundreds place. You move to that space. If you land on a star, then you receive a Force Card. "Okay, are there any questions?" There were none so the students went to their math groups. The game board looked like this:


Rebel Base
1
76
104
7
38
312
10
28
49
200
5
30
4
91
64
6
45
732
8
27
111
9
16
269
84
189
62
130
54
172
32
201
14
60
306
100
18
29
Target Death Star


Spinner
5
0
1
6
2
7
3
8
4
9
tens
hundreds
tens
ones
Lose 1 turn
hundreds
ones
Take another turn
ones
tens

The leaders are setting up their area while Mrs. Bell sees to it that the game group has two students at each table. There are four students here at the tables. Karen and Candy take one Star Wars game to the table where Mrs. Bell was sitting. Greg and Bob take the regular game table. Mrs. Bell asks the aide to please help Bob with the game. She explains in Spanish while Greg sets up the game. The time is 12:30. We discover at the girls' table that not all the combinations found on the spinner can be found on the game board. The rule is made if you can't find it, spin again. At 12:33 Kim joins our game group. . . .

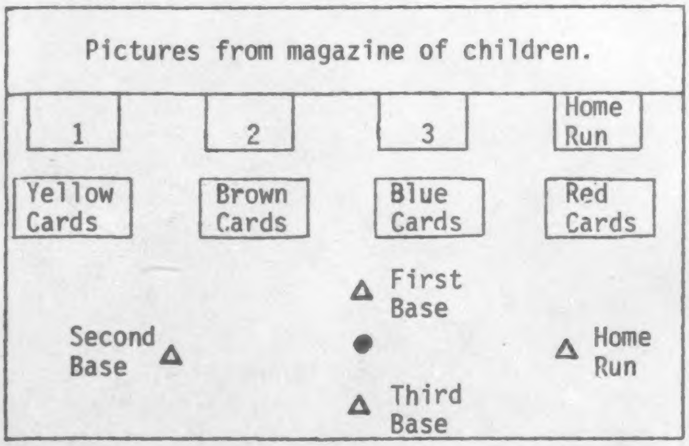
> . . .Greg and Bob are saying what they spin out loud and trying to read the Force Cards. I look on Greg and Bob to see how they play. They seem to understand and enjoy their new game. . . (B, 11/3, pp. 2-3, 4)

In the beginning of November, a Wednesday, Mrs. Smith taught a new game, Batter Up, a subtaction game, to a small group of children. The children appeared to learn the game rules easily enough but not all of them knew their subtraction facts well enough to play the game.

Mrs. Smith had been expecting the help of a father volunteer and possibly that of the MPS but neither showed up. The protocol indicates that the children stayed on task for the first round of the game, which took 15 minutes, but that after that disruptive, off-task behavior by one child in the group, *Larry, a target child, and by two boys who were then assigned to the independent worksheet group, was a constant factor on the rug when the game playing was taking place. These two children, Chuck and *Ken, apparently would have liked to join the game but as they weren't in the group instead played for the attention of group members in other ways. However, the game went on as if the children barely noticed Chuck's disruptive behavior. The excerpts from the protocol show how the game was set up and played through the first round and also includes an episode towards the end of the game where children disagree about the right answer.

Day 11: First Round of the Game

> . . .Mrs. Smith explained that the questions to this game were subtraction, sorted into levels of hardness. First Base questions were easy and the hardest questions were Home Runs. The game board looked this this:



One team played at a time. *Sally was asked by Mrs. Smith to be responsible for the rubber bands which went around the cards. The die had 1 2 3 HR SO (Strike Out) and W (Walk) on it. The object was to throw the die and look at what was thrown and then a card was chosen from under the proper space and answered before the student moved his disk. Example: a 2 was thrown. A 2 or brown card was taken, 10 - 5, and an answer of 5 was given. Then the student's disk would have moved 2 squares, which would have put him on second base. A score was kept on the blackboard for each team. At 12:24 this group (*Larry, Alex, *Ann, Sue, *Alice and *Sally) was left to play Batter Up while Mrs. Smith returned to the back table. At 12:25, Mrs. Smith returned to the game group where *Larry had just turned a HR on the die. The red card had the equation of 14 - 5, which was answered with a 9 and *he got his home run. After *Larry, came *Ann with another home run for the blue team. *Ann stated, "we don't need any help. We can do this by ourselves." *Sally and Sue were playing on the red team. By 12:28 Alex had joined the group and Mrs. Smith left to instruct the back table. As the teacher was leaving, "miss a question or throw a strike out, the other team plays." Alex had his turn as part of the blue team. He had the question, 15 - 9, which he couldn't answer. *Sally gave the answer 6 and blue was cleared off the board. *Larry had put 2 on the board for Team Blue's score. *Larry and *Ann had run off to tell Mrs. Smith of their game and score to be sure they were correct. (There might have been three strikes, like real baseball, that had confused them. . . (C, 11/5, pp. 2-3)

Day 11: End of the Game

. . .Everyone at the game laughed when *Ann and *Sally struck out. The score was 4 Blue, 2 Red. *Sally played with crossed fingers on both hands. Chuck had shocked *Larry again. *Ann reminded *Larry, "remember, *Larry, Chuck is your friend." "Not anymore," as *he walked over to Chuck with fight in his eyes. Mrs. Smith, "Chuck and *Ken, settle at a table." They settled at the table in the corner behind me where

> the orange beanbag was located. Sue had been counting on her fingers to arrive at the answer for 13 - 8. Counted, "12 11 10 9 8," answered "5." *Larry helped her count 12 11 10 9 8 and stopped. Sue cried because *Sally had said Sue was wrong as the answer should have been 6. Sue insisted the answer was 5. *Sally insisted the answer was 6. Sue got up from the group and went near the door while *Ann and *Sally had started to put the game away. I had asked, "why are you putting the game away?" "Because Sue is crying over her wrong answer." *Ann said, "Lord, Jesus Christ.". . . (C, 11/5, pp. 5-6)

After the groups rotated, Chuck and *Ken's group was scheduled to play Zooks. Again the first round of the game (taking about ten minutes) progressed more smoothly than the later rounds which became highly disruptive. Rita, a child mentioned previously in regard to dominance both at managing the game and initiating acting out behavior, was seen playing the same dominant role.

The following excerpt from the protocol shows children playing the Zooks game by their own rules, which were different from that of the teacher's rules, as the ethnographer's note indicates.

Day 11: Zooks

> . . .Opal passed out the cards to each person in the group. (The group at table): Chuck, *Ken, Rita, Opal, Lee and Toby (absent). Lee asked how the game was played. Opal: "If you want to know then read the card." *Ken was saying, "I go first." However, Rita appointed Opal to be first and then Lee. *Ken was to be third. *Ken was upset! After the first round, the group had to show *Ken how to show his card away from him. Opal said, "Zooks!" with only a count of 8 and started to clear all the cards off the rug. Rita counted before Opal took the cards and proved the sum was 8. *Ken said, "Zooks," first but wasn't chosen as first one saying Zooks. He then claimed he wasn't going to play. Rita reminded him, "you will have to play after school." From then on to be sure he is first, he yelled, "Zooks," for every play. Even with this system the group, mainly Rita, declared other players as winners. With what I thought would be the last two plays, *Ken got the cards for Zooks. *He and Opal tied for the last play. Rita handed Opal two cards and *Ken two cards for that hand. However, *Ken

> said, "Opal said it first." *He handed her his two cards which she accepted. At 1:03 Rita counted her cards. Somehow with her five cards left, she managed to go out the next round. Rita along with the other students, took the cards they had collected from Zooks and placed them in their hands to continue playing the game of Zooks. . . (C, 11/5, pp. 7-8)

Ethnographer's Note

> . . .Rule Four of Zooks stated: "When all cards have been turned up, the player with the most cards wins." However, the group played the game like "War," where the cards were turned over and over again until only one person had any cards left. I have not seen either teacher play any of the games all the way through, so I am not sure if the students really know how to play the games from beginning to end. . .

On the last observation day in the fall, the second Monday in November, Mrs. Bell had just tested her students on place value from the math book and the children had "whipped right through it." Mrs. Bell said, "they really surprised me. I now know all of this has been worth it." That day children were playing Star Wars again; some were with the aide and others independently. One of the children, Greg, showed the ethnographer his completed addition roll which went up to 1000. Another child, Candy, was at the addition tape, computer table working on Number 189 using blocks, longs, units and My Computer card. As the ethnographer watched, she did 190 perfectly. At the toothpick counting table, children ranged from 159-300's.

In Mrs. Smith's room, children were working on two and three digit addition with carrying, using rods to help them understand the process. A total-group game testing the subtraction facts showed that *Mike and *Sally, target students, were in need of more practice.

The excerpt from the protocol indicates that the "game" group was more easily managed when students were free to move to another activity after a few rounds when their natural interest in the game began to diminish.

Day 12: Episode One: The Game Group

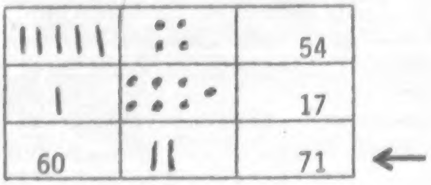
> . .
> . . .In *Mike's group, Ginger had returned after two weeks of pneumonia. Each person was

> dealt his cards. *Helen and Carol had tied for the first Zooks which *Mike had declared Carol as the winner. It was also agreed by *Helen. The next round had also ended in a tie again with *Helen and Carol. Carol was declared the winner again by *Mike. The next round had ended in a tie between *Helen and *Mike. Carol had declared *Mike the winner. (The game had ended by my standards as *Mike ran out of cards and would have to turn his Zooks winnings over in order to continue playing.) *Mike had run out of cards and *Helen said *Mike had to use his cards to have completed the game. Carol did not agree with *Helen; however, she gave in. The game had ended at 12:37 as *Mike only had enough cards for several rounds and Ginger had run out of cards as well. Carol had the most cards and was declared the winner. It was 12:38. . . (C, 11/10, p. 3)

Day 12: Episode Two: Using Rods for Explaining Place Value

> . . .The students were asked to copy: $\begin{array}{r} 275 \\ -\ 128 \\ \hline \end{array}$
>
> from the board. Chuck was asked to add 5 + 8. He answered, "13." "Do you have enough to trade?" Chuck guessed, "1," "3," and "5." Mrs. Smith asked, "how many ones do we trade for a long?" "Ten," answered Chuck. "How many ones do we have?" "Three," Chuck answered. Mrs. Smith, "How many in the TENS place?" Chuck, "ten." Mrs. Smith reminded the group that, "you can't put ten or two numbers in the tens place. So you put one set of tens in the HUNDREDS." Chuck, "403." "Right!" continued Mrs. Smith. "How many of you got that?" All the group raised their hands. Another problem was done: 348 + 129 = . This time Toby was asked to do it and he and Mrs. Smith went through the same process. It was taking three to four minutes for each problem. . . (C, 11/10, pp. 4-5)

Day 12: Episode Three: The Game Group Moves on to Individual Pursuits

> . . .At 12:52 decided to walk around this quiet room and see what the students were doing. *Mike was reading a book instead of doing math while at the math free center. *He was all settled into the black beanbag at the corner table near the window, while Ginger still was sitting on the orange beanbag doing her math facts. There was a covered half-gallon milk container which looked like a face. She put $\begin{array}{r}13\\-5\end{array}$ into the top slot and it came out the tongue end showing the answer 8 . Ginger followed this process with each equation. Said, "16 - 9." Held up nine fingers and counted, "16, 15, 14, 13, 12, 11, 10, 9, 8." Gave the answer, "7." Put the equation faceup into the forehead area of the milk container face and the answer 7 came out. This system worked for her everytime. *Helen and Carol were playing One Up. *Larry's group was working quietly and mostly in pairs at the tables away from the tan rug doing the math worksheet. I stopped to help *Ann and *Sally who were seated at the same table. They were not doing the worksheets correctly. They were adding 5 tens and 7 ones in order to get the corner box.
>
> 
>
>
> I pointed out to them it was like adding. "Add the ones then the tens and then together. Tell the numbers across and add them together. . . (C, 11/10, pp. 5-6)

Closing Interview of Classroom Teachers After the Fall Observation Period

The teachers were interviewed by the Principal Investigator and Ethnographic Assistant in December.

At this point, both teachers were satisfied with the new approach to mathematics instruction rather than using a textbook. Mrs. Bell said she was more sure that the children knew the material. Mrs. Smith felt that when children can explain a concept to others, e.g., visitors, then you know they got it.

The teachers had found Mrs. Jones, the MPS, to be very supportive and said that the children liked working with her. The math specialists had visited the room earlier in the fall to find out what help was needed. One day the MPS had come on the very day that assistance was requested to discuss what followup activity could be used for a particular lesson.

The teachers indicated that they were experimenting with various strategies to manage the grouping. Mrs. Smith tried to group students of like ability together. Mrs. Bell explained that at first she had inadvertently placed six very explosive children in one group. They all wanted to be leaders. Since then she had changed the grouping and most of these six had calmed down and were helpers. (One child with serious behavior problems had been referred to the social worker.) Mrs. Bell had also tried allowing the children to choose who to play with in the game group but that hadn't worked. Now she assigned children to groups.

In the beginning, the teachers had started out with six students playing a game but this caused problems as each child had too much time waiting for his turn. This resulted in a loss of interest in the game. Both teachers felt the games worked best with adult supervision. Both felt the games were an important vehicle of learning. Mrs. Smith said, "I believe children can learn better if they can interact with one another and share." Mrs. Bell saw progress in children's conduct in the game groups. Formerly, children lost their tempers when they were losing and disrupted the game; now the games could be completed. Mrs. Smith felt an open classroom such as this one was better even though it was an adjustment for all.

Mrs. Smith felt it was an advantage teaching second and third grade math in that it provided an overview and prospective of why a concept needed to be taught. She thought it would be helpful to attend a workshop on fourth grade math for this purpose.

Followup Study: Program Implementation in the Spring

In the spring, five additional observations, two of which were made of the MPS instructing target students, occurred over a month's time from early March to early April. The purpose of this followup was to determine whether or not our interpretation of the progress and its effect upon student learning would be influenced by a longer view of the treatment.

Classroom C was studying a unit on multiplication. Games were still a major part of the instructional program but towards the end of the observation period were not used as a required activity for the entire time that another group was working independently or with the teacher. More emphasis was placed upon using the games in instruction, followed by worksheets and free game playing on a choice basis. This seemed to be successful in reducing some of the acting out during unsupervised game playing. Conflict over such things as who should go first, and disagreement over rules was still a problem. Mrs. Smith planned to remove games as a center next year if she remained without an aide. Instead she would have two larger teaching groups for four days a week and one day for games which she would supervise. She felt games were a very important tool for learning math but that they required supervision.

The MPS, Mrs. Jones, spent two days in the classroom in March, teaching small groups fraction games and providing other manipulative activities building the concept of fractions. While the MPS was working with one group, Mrs. Smith was observed working with the others, suggesting a team approach for management purposes (protocol 3/16). Further activities about fractions were not observed in the classroom after the MPS left, but that may be because only two observations took place after the MPS visit.

Mrs. Smith now had seven mainstreamed students in her classroom and several more second grade students. Students were divided into groups of eight, eight and nine children. The following excerpt from a protocol showing the second MPS day in the classroom shows Mrs. Smith using games in instruction. It also shows the MPS making sure Ann*, a target child, stays in the room during the visit so that the child won't miss her turn at Title I services.

Second MPS Day

> . . .At 12:15 when the buzzer rang, the students moved to their proper math rooms. Mrs. Smith called a list of six names: *Ann, *Ken, *Helen, Carol, Ruth and Toby, who reported to Mrs. Jones (MPS) who also had a listing of the same children. I sat in the same area beside the MPS' table and in front of Mrs. Smith's desk. I didn't report to Mrs. Bell's room in order to capture the happenings of the MPS and the process used to teach fractions.
>
> The first group of children started with a game called Block Exchange, where the

group was asked what they thought the name of the game meant. Answers were received, from changing colors to trading shapes. The die had numbers 1-6 on it. The four boxes used yesterday were placed from small to largest in size next to each other and the other four boxes at the other end of the table were placed side-by-side in the same order. The die was thrown and the number appeared was the number of pieces taken from the first box containing the green △ s. The values worked where two green △ s were the same or equal to one blue ◇ and three green △ s were equal to one red trapezoid. Each student was given a board with six hexagons grouped together.

At 12:20 Greg was heard from the instruction table asking for "*Helen, *Helen, where is *Helen?" Mrs. Smith explained that *Helen was with the MPS today.

*Helen started the Block Exchange game and rolled a 2 on the die, where she took two green △ s.

The MPS reminded the group several times of the rule: "Only the person with the die may make the exchange."

Ruth rolled a 6 and reached for a yellow hexagon when she was stopped gently by the MPS's hand.

MPS: "Why did you reach for a yellow?"

Ruth: "Six △ s equal one yellow."

MPS: "Very good! Do all of you see," (holding six green △ s in one hand and one yellow hexagon in the other) that this is the same as this?" (Holding out her left hand with △ s and then the right hand holding a yellow hexagon.)

The student teacher joined the MPS' group at 12:25 with a cup of tea in hand. After watching the group for two minutes in a squatting position, the student teacher said, "it looks interesting! Could someone explain to me what you are doing?" Explanations were heard from each child in the group with the MPS having stated the most important rule: "The object is to use the fewest number of pieces possible in making an exchange."

The MPS reminded the group that if a short-cut was seen, then an exchange was not needed.

This group was interrupted at 12:32 by a lady who wanted to talk with *Ann, however when she learned the MPS was working now, she decided to take *Ann at 12:50 or so. *Ann wanted to go with the lady, but the lady was firm. The other children wanted to know what *Ann did with this lady and *Ann told them, "talk." The MPS had explained to the lady in front of the group that this was her time to work with *Ann as she was asked by Mrs. Smith. *Ann needed some assistance in making exchanges as she had 5 △ s and was taking a yellow hexagon instead of trading all her possible pieces (two red rhombuses) for one yellow hexagon.

The student teacher was observing today, going from group to group.

The game group was working quietly.

Mrs. Smith's group was playing a board game of Tic-Tac-Toe. Team A won, although I was unable to observe closely enough to know all the rules.

x

0	0	1	2	5	9
1		B			
2					
5		A	A	A	
9					B

At the MPS's table, an argument had occurred between *Ann and Ruth about a blue piece. *Ann felt Ruth took it when she shouldn't have. The MPS concentrated on Carol's turn before talking with *Ann.

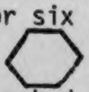
MPS: "Who is Ruth hurting?"

*Ann looked at Ruth and answered, "herself."

> MPS: "Right, so let's not pay any attention to it. Are we ready to go on?"
>
> Group: "Yes."
>
> In the meantime, Ruth placed the blue piece back into the box when Carol took another blue piece out and placed it on Ruth's board.
>
> Through most of the lesson, *Ken was swinging his foot, rocking his chair or kicking his chair.
>
> The student teacher arrived back to the group at 12:43.
>
> At 12:44 Mrs. Smith came and watched a few minutes with a large smile on her face. Then Mrs. Smith asked if rotation could occur shortly. "*Ken, are we in agreement that two triangles are equal to one rhombus?" *He had to think a moment and then agreed.
>
> The students placed their pieces in the boxes and Mrs. Jones (MPS) collected the boards.
>
> *Ann was close to completely covering her six hexagons.
>
> Rotation occurred at 12:50. . . (C, 3/18, pp. 1-5)

In our final observation, an interesting event took place. *Ken, a target child, invented a game which challenged the other children and gained a new respect from his peers.

Final Observation

> . . .There were seven students on the rug with the student teacher. *Ken had a new toothpick problem to share with the student teacher. He gave her 12 toothpicks and needed six pens for six pigs. The answer was a hexagon.
>
> 
>
> The student teacher had *Ken share this problem with everyone who was interested. All seven students tried and not all were able to do it. . . (C, 4/1, pp. 2-3)

Ethnographer's Comment

> . . .*Ken had gained a new respect from his classmates with his toothpick pigpen problem. The students were eager to learn the answer from him. Mrs. Smith was able to solve the pigpen problem on the first try. She was surprised!. . . (C, 4/1, Comments, pp. 2-3)

Summary

These two classrooms were implementing a mathematics program, based on the Title I model, where manipulative aides and math games were an integral part of the instructional plan. Small-group instruction was a main facet of the program. Supervision of active groups, e.g., game groups, counting groups, appeared to be one requirement of program implementation.

The main thrust of the math project appeared to be through the inservices and informal consultations with the Mathematics Project Specialists. Direct services of the MPS appeared to offer additional small-group assistance to the classroom teacher and target students, but did not conform to either a demonstration or team-teaching model.

Study B/C

Observation Schedule

Date	Day	Hours	Minutes
10/13/80	Mon.		55
10/16/80	Thurs.	1	25
10/21/80	Tues.	1	
10/22/80	Wed.	1	5
10/23/80	Thurs.	1	5
10/24/80	Fri.	1	8
10/27/80	Mon.	1	
10/28/80	Tues.	1	
10/28/80	Tues.	1	
10/29/80	Wed.		40
11/3/80	Mon.		35
11/5/80	Wed.	1	6
11/10/80	Mon.	1	8

TOTAL - Days: 13 Hours: 13 Minutes: 7

Study B/C Follow-up

3/11/81	Wed.	1	
3/16/81	Mon.	1	2
3/18/81	Wed.	1	2
3/30/81	Mon.	1	2
4/1/81	Wed.	1	5

TOTAL - Days: 5 Hours: 5 Minutes: 11

Classroom Ethnography Case Study
for Research Site D

Context of the Research Setting

Research Site D was a combination Grade 2/3 classroom with 18 students located in an attendance area of very low income, Mexican-American families. The achievement level of students as measured by standardized tests was among the lowest in the city. The teacher, aide and many of the students were bilingual and instruction was often observed to be in Spanish and English.

The mathematics program was scheduled for 35 minutes a day, from 10:45 to 11:20. Teacher and aide alternated groups of students who were grouped by grade level, with eight Grade 3 students (all Title I math participants) and ten Grade 2 students. (Fifteen of the 18 students were identified as Title I target students for receiving supplementary services.)

In an initial interview, the teacher was very supportive of the research and was interested in anything that might help improve the students' achievement. She suggested that the ethnographic assistant conduct nonparticipant observations, which she felt would improve the accuracy of the data. The teacher had previously taught a 3/4 combination class and found her present class of 2/3 to be very low in their achievement.

The teacher (identified as Mrs. T), had participated the previous year in the Mathematics Resources Project. She felt that the project offered very good ideas but that it is sometimes hard to implement them in the reality of the classroom. Mrs. T felt it would be helpful if teachers received training in how to get the most out of working with resource teachers.

Organization of this report

Initials were used to designate individuals. (This was an early study; later we used pseudonyms for identifying persons.) The classroom teacher is Mrs. T, the aide is Mrs. A and the substitute teacher is Mrs. S. Excerpts from protocols are referenced by case study letter, i.e., D, month/day and page number.

First Observations

The first three observations indicated that the math program was focused upon counting and the construction of graphs. The following protocol describes the classroom setting.

Day 1a. . . .Entered room at 10:45 to find half the class sitting on rug in front of side blackboard. The teacher was asking the children to construct "ask" and "tell" questions. Each time she asked for a new type of question,

> there were at least two to three children who raised their hands. Mrs. T would sometimes respond to children with raised hands, but she would also turn to other students who had not raised their hands. In questioning these last children, the teacher would leap into Spanish in completing her request. Thus Mrs. T would use English and Spanish interchangeably. This was also true in math explanations.
>
> Mrs. T explained to the class that we were waiting for the Grade 3 students to appear and that math would begin as soon as they returned. Thus the children on the rug were Grade 2 students. I took the intervening five minutes or so to scan the classroom. The room itself had a high ceiling, several large windows facing west and north and two doors. While there were quite a few bookshelves and cupboards arranged around the room, there were only four work tables that looked as if they were students' desks. Out of these four, only two had baskets for completed work. One table was located in the northwest corner of the room and was empty; I did not see any children sitting at it. The fourth table was semicircular and situated at the front of the room, very close to both a blackboard and a set of bookshelves. No work baskets were on this table. The room was decorated with many different Halloween pictures. Some decorations were on the four walls, while other ones hung from the ceiling. All children were wearing pumpkin name tags. . . (D, 10,20, pp. 1-2)

The observation of the first day that the ethnographer was in the room, a Monday, focused upon the aide working with the Grade 3 students (all of whom were Title I target students). Using the board and a set of printed instructions, the aide asked students to respond as a group in identifying odd-even numbers for 1-20. Later in the lesson she interspersed questions about the place value of two-digit numbers with questions about whether the numbers were odd or even.

Day 1b. . . .Mrs. A: "Look at 11, what does it stand for? It is an odd number; 11 = 10 + 1. Is ten even or odd?" "Even," the children say. "Okay, but what does the first one

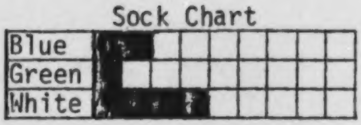
> in 11 stand for?" (11). "Ten," she answers her own question, Mrs. A continues to the number 12, asking once again what the one stands for in 12. The only difficulty here was that she (Mrs. A) did not explicitly say one, but instead would point to the number 12. It was hard to tell if she was pointing at the whole number, or just part of it. Mrs. A points out that 12 = 10 + 2 and then follows the same procedure with 13 and 14, noting in each case that the one stood for ten. "Who understands how to do this?" Mrs. A asks. All children raise their hands. "R, what does the one stand for in 16?" "Ten," he replies. Mrs. A: "Is it even or odd?" No answer. During this interaction only three children are actively paying attention by looking at the aide as she talks. Three other children are talking and laughing with each other. "Okay group, how do you tell if a number is even?" "By twos," one boy replies. "No," another says, "by the second number." . . . (D, 10/20, pp. 3-4)

The aide then guided the group through a workbook lesson requiring students to write odd or even beneath pictures of sets of objects. At the end of the lesson, the aide wrote the numbers 1-30 on the board and asked a child to circle the even numbers. After the group counted the circles, the aide read a workbook question, "If there are 30 numbers, and 15 are even, how many numbers are odd?" and asked the students to write the answer. Students couldn't do the problem except for one child who explained to another child that 15 + 15 = 30.

The second observation on a Friday showed the teacher working with the Grade 3 group in their workbook (Math Around Us, Scott, Foresman, Grade 3). The lesson focused on counting of pictured objects and the concepts of shorter/taller, more/less. As part of the lesson, the teacher drew a chart on the board illustrating the colors of the children's socks.

Day 2a. . . .The teacher changes the subject somewhat by asking the children to bend over and look at their socks. She adds that they are going to make a chart like the one in the book, only their chart is about the color of their socks. The teacher turns around to the blackboard and draws the following chart:

Sock Chart



> The teacher tells the group that on their chart, the votes will go across, instead of up and down. Mrs. T: "All those with blue socks raise your hands." Four children raise their hands, but the teacher points out that only two of them really have blue socks on. "And how many with green?" One child raises his hand. "How many with white?" Four children raise their hands. "So," the teacher continues, "how many squares do I fill in?" The children reply, "four." Mrs. T: "Our sock chart tells us that we have two people with blue socks, one with green socks, and four with white socks.
>
> The teacher continues her explanation of charts by explaining that charts tell you things about numbers without writing out numbers. . . (D, 10/24, pp. 3-4)

A great deal of teacher guidance was required in order for the children to complete the workbook task. All this time the Grade 2 group had been working quietly with the aide.

Day 2b. . . .11:15 (a small bell goes off). At the Grade 3 table, children are working at their own pace, some (two girls) are on Problem 3, while a trio of boys are unsure of Problem 2; the teacher explains it in Spanish to them and then turns to the two girls working on Problem 3 and reads it out loud to them: "Which story has fewer votes than 'Hansel and Gretal?'" The two girls decide the answer. While the two girls write out their answers, the teacher helps other children with Problems 2 and 3. 11:20. Problem 4 is read by the teacher to the two girls: "Which stories have the same number of votes; the most votes; and the least votes?" As the two girls finish the workbook page, Mrs. T tells them to put their name at the top of the page and tear the page out of their book. 11:23. Second graders are finished; are getting up from their table. At the Grade 3 table,

> three boys (R, J, and G) are still working out Problem 3 and are trying to decide which number, four or five is the largest. "¿Cual es más grande, y cual es más chico?" the teacher asks. The teacher continued to work with these boys until finished, even though the rest of the class was on their feet, either waiting to go to lunch or putting away their materials. . . (D, 10/24, p. 6)

On Friday the aide wasn't present and the teacher instructed the total group (17) on a lesson on graphs. The lesson began with a review of the week's work on graphs which lead into a followup of the workbook exercise in which the class constructed a graph of favorite TV shows. The following protocol illustrates how Mrs. T explained the function of the graph with counting.

> Day 3. . . . Mrs. T asks the winning group how they knew that they won. Several boys yell out, "most names, most votes." Mrs. T: "Without counting how can you tell who won?" A (girl): "The show which is the highest." The teacher repeats her question. M (boy): "The one which is higher than all the other ones." The teacher agrees by repeating these comments: "It is the one with the longest or tallest list of names." She then asks which show had the smallest list of names or was the least favorite. The children call out together: "Charlie's Angels!" They also responded quickly when asked what the second favorite TV show was--soap operas. The teacher continues this type of questioning by asking about the third and fourth favorite shows. Once again the children respond quickly and correctly. 11:10. The teacher says: "Okay, now let's count to see if we were right." Together they count the number of votes for each show; the teacher writes these numbers underneath each show's ranking. They conclude that they were right in their first popularity decisions. Mrs. T: "So in our class, our favorite show is 'That's Incredible.'". . . (D, 10/27, pp. 3-4)

Direct Services of the Mathematics Project Specialist

The mathematics project specialist (MPS), Joanne, came into the classroom to work with target students once during the four-week observation period (one other visit had been scheduled but was canceled due to extenuating circumstances. As the complete protocol (D, 10/28/81) is found in Appendix A, only a summary will be included here.

During her visit, Joanne worked with two groups of four target students each on basic facts activities (Mrs. T had requested a basic facts presentation). The MPS used special dice to explain the concepts of doubles and to informally assess the group's knowledge of the "doubles" addition facts. Since this called for a group response, it was hard to tell whether or not the whole group knew the answer or only student A, who answered first each time. The doubles facts, 1-9, were then written on the board for children to refer to when playing Drag Strip, a game requiring individual students to double the number shown on the dice. All the children referred to the facts written on the board in playing the game, except student A, which indicated that most had not yet learned these facts (and also shows the limitations, in terms of diagnosis, of group responses). The situation observed in the game on which the MPS imposed restraints on group responses, provided more information to the MPS regarding the skill level of the target students.

The shortness of the math period, e.g., 35 minutes (the amount of time suggested by District and State curriculum guides for math in primary grades) also imposed constraints on the services offered by the MPS. As the protocol indicated, it was difficult for the MPS to complete the teaching of a second game, Zooks, within the time allotted. The Zooks game was a card game requiring the recognition of doubles. Joanne left the game behind when she left for the children to play later.

Classroom Observations of the Mathematics Program After the Mathematics Project Specialist's Visit is Over

The fifth observation day occurred while Mrs. S, a substitute teacher, was in the room. After math workbook activities were completed, Mrs. S asked the children to "write the numbers to 100 by twos!" Students having difficulty are shown the addition method of 2 + 2, 4 + 2, etc. This helps most children, except V who may have a learning disability, to perform the task. Most of the children can write numbers by twos and three girls complete the task by counting in unison.

Day 5. . . .11:19. I have walked around to three-fourths
of the tables and have noticed that while one
to two children per table are unable to do the

> problems, several children in the class are working in the 90s and will soon reach 100. In particular is a trio of girls, of whom A is one, who are at "88." They count in unison each number 1, 2, 3, 4, 5, 6, etc. and then write down the even numbers. They are able to work rapidly. . .
> (D, 10/29, p. 4)

When Mrs. T returned on Monday she began a unit on basic facts by asking the children what they thought the term meant. To this one boy called out, "food." Mrs. T then went on to explain that basic facts is a fancy word for number problems that all of us keep in our head. Then she began a review of a few doubles facts, e.g., 2 + 2, 0 + 0, 1 + 1. Many responses were in unison orally or by showing their answer on their hands. Later, the zero facts were introduced by a diagram of sets drawn on the board and a lesson on the zero facts, e.g., 0 + 1 . . . 0 + 10. The protocol (11/3/80 in Appendix B) indicates that all the children understood these facts.

On Wednesday, instruction focused upon the zero facts, addition of doubles and patterns of double facts. Mrs. T used whole-group, recitation-organized instruction with manipulatives used briefly at the beginning of the period followed by board work and math worksheets. The aide mentioned that students are asked to work at the board so that one can determine each individual's mastery of the facts.

Day 7. . . .Using snap-together cubes, the teacher displays the problem 1 + 0 on the cardboard circles. Each time she looks up at the students and asks what the answer is. The problems go from 1 + 0 to 9 + 0. All answers are correctly given by the students. As the answers are called out, the teacher arranges the appropriate number of cubes and lays them out after the "=" sign. The children are paying attention but as there are 18 of them on the rug, they are sitting close together. Consequently, there is some talking and squirming. (There is noise from a class passing through the hall, so I get up to close the door.) By 10:50 the class has finished with their "0 +" problems, so the teacher tells them that they are going to learn their doubles. She asks them what 0 + 0 is ("0," they all reply) and 1 + 1 ("2," they yell). For the problem 2 + 2, the teacher places two cubes on each circle and asks the class to tell her the answer. They correctly reply with 4. Stopping to ask the class to listen carefully to her, Mrs. T asks them which problem is next. No one answers, so she explains that they are counting by twos. She calls out the number 3, then the number 4--stressing that 4 + 4 is the next problem. As the teacher calls out the numbers, stressing the doubles problems she lays out four cubes, then six cubes, then eight cubes and then 10 cubes on each circle, to illustrate the doubles problems.

The class is calling out the numbers in unison and as they stress the 4, 6, 8, 10 numbers, D suddenly remembers a nursery rhyme: "10--Big fat hen," D repeats the rhyme but is stopped by the teacher.

She asks the class to tell her what they are doing with numbers. Someone yells out that they are counting by twos. Someone else adds that they are putting the numbers in order. Mrs. T agrees but reminds them that they are putting the numbers in groups of twos, just like their nursery rhyme which helps them count by twos. . .

. . .Two minutes later the teacher stands up and turns to write the problems in order on the board: 0 + 0 . . . 10 + 10. She does not ask the students for the answers as she writes the complete problem. The teacher asks the students to look at the numbers on the board and to raise their hands when they see something about the numbers. The children begin to call out their responses before the teacher can call on them: (1) "2, 4, 6, 8, 10," says one child, (2) "they go in order," (3) "they took one away" (?). After hearing these first comments the teacher agrees that they go in order but asks J to show her what goes in order. J calls off, "1, 2, 3, 4, 5, 6," and is told by the teacher that he is right. She continues asking about the answers--what do they (the students) notice about them? G calls out that the answers go by twos. The students are instructed by the teacher to count out the answers on their fingers: 2, (3), 4, (5), 6, (7), 8, etc. . . .

. . .Mrs. T erases all the answers and then asks C to come up to the board and write out

> all the answers. C comes to the board and correctly solves each problem from 1-20. As C works, most of the teacher's attention is on him. When he finishes she remarks to the rest of the class that C has worked these problems by counting by twos. C goes back to his seat on the rug; the class claps for him.
>
> The board is again erased and B is asked to complete the problems. He works the first two problems but has to have the teacher's assistance to solve 2 + 2, 3 + 3 . . . 6 + 6. The teacher explains the problems by asking what is "two more than the last answer?" It takes several minutes for the teacher to help B work the partial set of problems (he only goes through 6 + 6). In the meantime, the other students are becoming more restless, talking to each other and poking each other. The aide notices the growing noise and tells them to be quiet, adding that they need to learn this. She (Mrs. A) turns to me explaining that by sending individual students to the board they (aide and teacher) are able to learn which students need extra help. . . (D, 11/5, pp. 1-4)

On Thursday, the eighth observation day, grouping students into three groups to facilitate using mathematical games was observed for the first time. At about this time the Mathematics Specialist and classroom teacher had met after school for an hour-and-a-half conference regarding classroom organization and management.

The protocol, presented in Appendix C, shows the student teacher playing two zero-facts mathematics games (suggested in the Title I mathematics inservices) with the students and indicates high student interest in and enjoyment of the game. Students in an independent group worked on zero facts as did the teacher-led group. There was time only to rotate two groups within the half-hour period.

On Monday, the ninth observation day, the lesson began as the teacher asked a child to question the other children on their zero facts, which were correctly answered. Then the teacher randomly ordered the zero facts; these also were correctly answered. After that the teacher reviewed the meaning of doubles before dividing the class into two groups to play a competitive "doubles" game with her and the aide.

Day 9. . . .The teacher then asks her student to tell her what "doubles" means. Two answers are given to her: (1) "Two numbers that are the same," and (2) "Two sets of the same." The teacher praises these definitions and stresses that doubles are two of the same thing (emphasis on same).

As another example of doubles, the teacher reminds them that two people who are the same are called twins. She then asks the students to give her some number examples of doubles. V calls out, "4 + 4 and 6 + 6," and F offers the doubles, "100 + 100." The teacher turns to P and asks him to give her a double. No answer. Meanwhile, other children were eager to supply doubles: 3 + 3, 7 + 7, 9 + 9, 99 + 99. The teacher agrees that these are all doubles and then repeats her original definition of doubles.

At 11:10 the teacher divides her class into two groups of six, sending one group to work with the aide at Table Four, while the teacher works with the other children at Table One. All children are given small pieces of paper and a crayon. The teacher and aide each have a pair of dice.

At Table Four the aide throws the dice and then asks the children if it shows a double. If it is a double, then all children are to write out the doubles addition plus the correct answer. They take turns throwing dice and pay close attention to the numbers on the dice. The first double they get is 5 + 5 = 10. All six children write the problem on their papers. As they continue rolling the dice, D gets upset because someone is taking a turn out of place. The aide quiets him and tells the group that they are having a race with the other group of students.

At Table One the teacher explains this same task to her students: "Everyone gets to roll the dice and if a doubles is rolled, someone must call out the word doubles so everyone can write the problem on their paper." The children ask the teacher if they need to write the doubles' answer. The teacher says that of course they must write the answer.

(Typically a table will roll several doubles in a row and then go for several minutes without rolling any.)

The teacher reminds her students that after this game is over they are going to see who has the most doubles. By 11:16 this group has rolled: 6 + 6, 1 + 1, 1 + 1, 4 + 4 and 6 + 6. Everyone has thrown the dice two times, so the teacher asks them to tell her how many throws in total they have had if there are six people with two throws each. G tells here that there have been 12. Each child is given another throw and then by 11:22 the children agree to let the teacher roll the dice for the remaining few minutes so they can get as many doubles as possible. The children look carefully at each throw to see if they have gotten a new double.

Table Four is hurrying (prompted by the aide) to write all the answers to the doubles problems that are already written on their papers. As they work, two-thirds of the children are standing by the table instead of sitting. The aide helps them with the answers.

Two minutes later, the teacher stands up and tells all the children (at both tables) to take their papers and go sit on the rug. The two groups sit opposite each other on the rug. The teacher starts the procedures by asking the Table Four team if they got each of the doubles on Table One's list. (meanwhile the aide is handing out the lunch cards.) Table Four had all the doubles except for one, so Table One received one point. Then it was Table Four's turn to read off their doubles. D assumed leadership by calling off the doubles. There were two doubles that Table One did not have, so Table Four received two points. D ends his comments by asking if they (Table One) got the double "8 + 8." "No," the other group replies and then the teacher realizes that an 8's double is not possible. D breaks out with laughter at being caught. 11:27. The teacher informs D's group that they have won and can go to lunch first. . . (D, 11/10, pp. 2-4)

On the last observation day, Wednesday, students were again divided into three groups which were not rotated that day. All groups worked on the doubles facts. Two of the groups used dice as part of their activities, and waiting for doubles to turn up by chance was somewhat of a problem.

The student teacher directed the game "Drag Strip" which had been introduced previously by the Title I project specialist, and the protocol indicated that students who were winning liked the game while those who didn't get doubles did not.

Day 10a. . . .The student teacher explained that the way to move along the strip and win the game was by rolling doubles with the dice and by correctly answering the doubles addition. The children were very quick in determining whether a doubles had been rolled, but the group was finding it a lengthy process to roll enough doubles for everyone to move along the strip at a relatively rapid pace. The children were quiet and were giving a great deal of attention to the game and to the individual player whose turn it was to roll the dice.

> By 11:07 the students at Table Four have been playing the game for 15 minutes or so and are getting restless because they have not rolled many doubles. E kept repeating to everyone that the game is a bore! (E was still on square one.) C on the other hand, had rolled several doubles, gotten all his answers correct and was winning. He liked the game and said so. At this point, some of the children were sitting in their chairs, but three to four of them were standing and leaning over the table to see each throw of the dice. . . .
>
> . . .At Table Four, E has rolled several doubles, is expressing much pleasure over the game she first thought was boring, and is winning the game. The group has progressed about two-thirds of the way through or along the strip. . . .
>
> . . .The student teacher is explaining to the teacher that his group had had difficulties rolling enough doubles. The student teacher added that partway through the game, he had altered the rules, asking the children to roll

> one dice and double whatever number they got. . .
> (D, 11/12, pp. 3, 5)

The teacher's group worked on a cutting and pasting task that also involved getting doubles. While this activity was time consuming, it appeared to hold the children's interest.

Day 10b. . . .At Table Three, the teacher is leading a group of six children in a dice rolling project. The object of this game was for each student to take a turn rolling the dice to see if s/he would roll a double. If a child did so, then the teacher would instruct them to look at the worksheet in front of them. This worksheet was the second sheet of the pair handed out to Table One students (see attachment). (This table also had jars of glue and scissors in the center of the workspace.) The worksheet shows a number of different domino faces. According to the doubles just rolled, the teacher and students would scan the sheet for the domino face with the same number. For example, if a 5's double was rolled, the group would then locate the domino face with five circles on it and then cut out the domino shape from each of the two matching worksheets. This then was how the glue and scissors were used, as the two matching (cutout) domino faces were glued onto a blank piece of paper that each child was given. Then the children were instructed to write the corresponding doubles-addition problem underneath the cutouts (example: 5 + 5 = 10).

> As the children took turns rolling the dice, they found it difficult to roll frequent doubles. Their attention to the task was evident, as they quietly waited until the next person had rolled the dice before eagerly looking at the outcome. At the beginning of the task, doubles were rolled, but after two trys by each member of the group, they still had not rolled a second double.

> The first double rolled was 4 + 4, so the teacher instructed the students to cut and paste the two domino faces with "4" on them. It took several minutes for the students to

> cut out the figures. The teacher looked around to me (at this point) and noted that she should have had the figures cut out beforehand. The teacher turned back to her group and helped P and two other children by cutting out their figures. The teacher's instructions about where and how to glue the figures were repeated several times for different students who weren't sure of how to do the task. As they finished their first doubles problem, P looked down at his paper and announced that 4 + 4 = 8. . . .
>
> . . .At 11:16 the Table Three students have finished five problems. The children are quiet and concentrating on the cutting and gluing. The teacher tells them that they only need one more double as they have already rolled 4 + 4, 1 + 1, 6 + 6, 3 + 3, and 2 + 2. . . .
>
> . . .The students at Table Three have finally rolled the 5 + 5 double and are completing this last exercise. As they do so, the teacher tells them to put their names on their papers and turn them in. . .
> (D, 11/12, pp. 1-3, 4, 5)

Summary

These observations over the period of a month showed the teacher using a variety of methods to teach the zeros, counting by twos and doubles facts to second and third grade students. During most of the lessons it appeared that most of the children knew these facts although the responses of a few individual children (V and B) indicated incomplete mastery.

Games were introduced by the mathematics project specialist and were used later in small-group classroom instruction for children to practice facts they alreay knew. Manipulatives such as the Powers of Ten Kit or cuisenaire rods were not observed in use in the instructional process. However, pictures and snap-together cubes were used to illustrate the zeros facts. Numbers and problems written on the board were observed frequently in the instructional process as was group-unison oral responses. Individual questioning and help for slower students was also observed. There was some indication of a change in classroom organization to using smaller groups and games after the teacher-MPS conference, but it is unclear if this was due to the project or the presence of another adult, the student teacher, in the room.

TUSD L&RS HS/se 5/19/81

Study D

Observation Schedule

Date	Day	Hours	Minutes
10/20/80	Mon.		40
10/24/80	Fri.		51
10/27/80	Mon.		55
10/28/80	Tues.		55
10/29/80	Wed.		40
11/3/80	Mon.		45
11/5/80	Wed.		45
11/6/80	Thurs.		43
11/10/80	Mon.		45
11/12/80	Wed.		45

TOTAL - Days: 10 Hours: 7 Minutes: 44

Classroom Ethnography Case Study
for Research Site E

Context of the Research Study

Classroom E, a fifth grade classroom, was located in a school undergoing court-ordered desegregation. It was served by several federal programs. Children in this classroom participated in the ESAA program (a program providing funds for desegregating districts) and the Title I program. The ethnic breakdown of the classroom was 17 Mexican American, 10 Anglo, 1 Indian and 1 Anglo/German students.

The weekly classroom schedule was very complex and required a high level of management skills on the part of the teacher. The ESAA program provided music and art. There was a school band (9:15 - 10:30 M-TH) and orchestra (M, W, 10-11). A few children (4) went out of the room to go to the LD teacher and others went to speech (T-Th, 11-11:30). A group of 10 students went out of the room to the Title I-ESAA Basic Skills Center (M-Th, 12:45 - 1:15). A few children volunteered for Spanish class (1:15 - 1:45). The regular schedule included silent reading, (8:20 - 8:50), library (W, 10:30 - 11) and PE (10:00 - 10:30). Math and reading were taught every day. Math was sometimes taught in the morning and sometimes after lunch, and observations were scheduled accordingly.

During the observation period in January and February, the teacher was teaching a unit on fractions. This was her third year of participating in the Title I mathematic resources project. She had worked with Mrs. P, the Mathematics Project Assistant previously and one of the other project specialists, Mrs. X had also worked in her room.

In the past, the classroom teacher had found the worksheets provided by the project very useful, but only used manipulatives occasionally and for a treat largely because of the time required for planning and setting up for their use. She expressed a high regard for the project.

Organization of this Report

The analysis of this case study is based upon protocols from 15 classroom observations and one observation of a mathematics inservice. Some of the protocols were for periods of almost three hours in length. Items in the text which pertain to descriptions found in the research protocols are referenced by the code letter for the classroom, i.e., E, followed by the month, day and line number, all enclosed in parentheses--for example (E, 1/27, 25). All names are fictitious and do not necessarily reflect ethnicity. The names of Title I target students are followed by an asterisk. Excerpts from a few protocols are found in the appendix.

Pertinent names are:

Ms. W. : Classroom Teacher (CT)
Mrs. R.: Classroom Aide
Mrs. B.: Classroom Aide (replacement)
Mrs. P.: Mathematics Project Specialist (MPS)
Mrs. O.: Mathematics Project Specialist (MPS)
Mrs. X.: Mathematics Project Specialist (MPS)

Title I target students were: Carol, Michael, Thomas, Don, Danny, Roberto, Troy, Katherine, Stephen, Gerald, and John.

The Classroom Mathematics Program Before the Mathematics Project Specialist Enter the Classroom

During the two observation weeks before the MPS entered the classroom, the classroom teacher had introduced a unit on fractions and attended a half-day mathematics workshop on teaching fractions. She defined the terms fraction, numerator, denominator and whole and illustrated these words with numeric symbols, leading to concepts of one-half, one third, one fourth, etc. The following fractions and fraction sentences were introduced: fifteenths (E, 1/19, 75), eights and sixteenths (E, 1/21, 54-73; 84-93), halves, fourths, eighths and sixteenths (E, 1/22, 33-40), tenths (E, 1/27, 357), sixteenths (E, 1/28, 72-74), and tenths (E, 1/29, 26-34).

Activities used in instruction were (1) referring to objects familiar to the students such as articles of clothing to illustrate the concept of fractions, (2) using strips of paper to represent fractional families (shown in the math inservice), and (3) math games that had been introduced and played at the inservice. A protocol describing the inservice is found in Appendix A.

Minor but frequent disruptions of mathematics lessons were observed as individual or small groups of students came and went to various pullout programs. For instance, during one hour students were observed leaving for Speech, returning from Spanish and the LD teacher at various times during the math period (E, 1/21, 45; 107-144).

Math games were a part of the fractions unit. The teacher usually moved from group to group during the activities period, quickly answering any questions that came up during the game playing. The game rules were somewhat modified by the children in that when they played Roll and Remove they put fractional pieces on their square rather than removing fractional pieces. The math content of the game remained the same but perhaps it was psychologically easier for the children to add rather than remove pieces. The game technique was also a way for a monolingual Spanish-speaking child to participate.

Day 4. . . .The game the students are playing was taught in last Thursday's workshop. (Refer to protocol for game description.) But this group is playing a new version. They roll the die to put fractional pieces on their game square. A player continues to roll until he/she cannot put an indicated piece on the board, then passes the die to the right. Students are to say outloud what they rolled. And the are not to help each other.

James is the first to cover his game board. Kim records his winning. No one comments on the winning other than to say he won. The boards are cleared and a new game starts.

I move to the group by the front blackboard. In this group are Brenda, Alice, Gerald, Pete, Jake, Will and Linda. Linda does not speak English. She marks her pieces so that others check her, and she will know the pieces without speaking.

Steve comes in from LD and joins the group.

A cheater is called in the group by the west blackboard. This group stops their play to listen.

Ms. W. asks Peg to explain what happened. Then Troy (the one accused) explains.

Our group resumes its play. Soon Linda wins. She doesn't say so, but motions her win. A new game begins. . . (E, 1/27, 97-135)

Later the students learned a similar game, Fractional-Coverup, which was played with rods (see Appendix B). Students were intent on seeing that others obeyed the rules and played fair. Supervision in the game playing was provided by both teacher and aide.

The next day the children's version of Roll and Remove, e.g. Roll and Add, was again played. The following protocol (written by the principal investigator) discussed the difference between a math error and a strategic error and describes how the teacher attempted to have students monitor each other's move. It also shows how games can encourage student's creative thinking and problem solving.

Day 5a. Math Error vs. Strategic Error

. . .The students had arranged their desks in a tight fitting arrangement in order to play the game. This seemed comfortable and satisfactory to the children. This was a mixed ethnic group of Anglo and Mexican-American children and one black male child. The materials for the game were a wooden die with fractions on the die written lightly in pencil (1/2, 1/4, 1/8, 1/16, etc). It was hard to discover the fractional part from any child's throw because of the lightness of the pencil figure. Each child had a red square of paper representing one whole and strips of paper which were color coded blue 1/2; orange 1/8; purple 1/4; yellow 1/16. In playing the game, the students appeared to be interested and involved and while "winning" was important to them, they seemed to accept it when someone else won and were eager to play it again to try and win. In round one the object of the game was to cover the whole red sheet as fast as possible with fractional parts, each child having one turn at a time. Larger fractions were therefore desirable. Because of the lightness of the written fractions on the die it was hard for the children to monitor the occurence of each other's moves. In observing these games it is always of interest to note the number and possible reason for observed errors. In this game I observed only one error, that of a black male student, Carlos, who placed a 1/4 piece of paper down for a 1/8 throw, an error to his advantage in winning the game which went unnoticed by the others. The teacher at this time was with another group but she afterwards gave general instructions to the class that they should be checking the accuracy of each other's moves and later gave explicit instructions to this group. The same child noted above played the same 1/8 through correctly later in the game suggesting that his first error had not been a math error but a strategic error.

The teacher mentioned that one reason she needed to keep in touch with how the children were playing the math games was that often they invented their own rules. She felt that the children's

> version of the game was usually as good as the original game and had the benefit of being understood by them--if the children didn't understand it on their own they couldn't play it. . . (E, 1/28, 32-64)

Day 5b. Mathematics Problem Solving Through Games

> . . .In the board group, after several rounds with different children "winning," the children began discussing fraction 1/32 and how one could make it out of the 1/16 piece by folding. They were also discussing whether a person would lose their turn if one ran out of pieces. From this they began to think about making more small fractions out of larger fractions by folding the paper. All seemed interested and involved in the conversation. This peer group discourse was continued when the teacher joined the group. Dee Dee demonstrated for the teacher the folding of blue (1/2) to make two 1/4 pieces. Debbie said, "If you get 2/16 (in the roll of the die) you just fold 1/8 in half and fold it up and open it up (to use it)." At 1:45 the children were not playing the game but discussing the folding and what fractions would result in a way that indicated understanding of proportion. . . (E, 1/28, 74-86)

Because the class had students with a wide range of achievement, instruction in small groups especially benefited the lower achievers, who participated more actively in the smaller groups than in whole-group instruction. It was the higher achievers who verbally interacted the most with the teacher in whole-group recitation organized instruction. It was our impression that the teacher-student discourse in whole-group instruction required the quick responses that higher achievers readily gave in order to maintain the pace of the lesson. (E, 1/28, 140-169).

Direct Services of the Mathematics Project Specialist

The Mathematics Project Specialist (MPS) entered the classroom during the third week of the study. The MPS began her lesson to a selected group of target students by introducing fractions using pattern blocks and the game of One, at a table at the rear of the room. At the same time the classroom teacher gave a lesson on fractional equivalents and number lines to the rest of the class. While it may have seemed that the MPS was duplicating lessons already learned, the protocol indicates that the students had not grasped the fundamentals of fractions as expressed geometrically through pattern blocks and found the exercises and game of One challenging. The protocol is found in Appendix C. The game of One required students to understand how two or more, same or different, fractions added up to one whole using cards with fractional numbers written on them. The concept of adding fractions had not been addressed previously, and proved to be difficult for the target students.

Day 7. Game of "One"

> . . .P. goes through the directions: each player will receive seven cards; the object is to make 1 whole. For example, 2/6 + 2/6 + 2/6 = 1 whole.
>
> Thomas* shuffles the cards and deals seven to each player.
>
> Will turns away from the table to sort his cards in his lap.
>
> P. tells the students to fix their cards so all 1/2's, 1/6's and 1/3's are together.
>
> Jake is first to start. P. helps him put 1/3 + 1/3 + 1/3 down to make 1 whole, and then tells him to draw.
>
> Next, P. Helps Will with 1/3 + 2/3's. Will has difficult comprehending discarding.
>
> Next, P. helps Roberto* who has several "wholes," but is not putting them down. P. writes the combinations on the board to illustrate and clarify the objective; 4/6 + 2/6; 1/3 + 2/3. Roberto puts down his "wholes" and discards.
>
> P. helps Katherine*. A 2/3's is on the discard pile. She has a 1/3 and 2/6 card in her hand. P. asks Katherine if she wants the 2/3's card or to draw. Katherine chooses the 2/3's card, but places it with her 2/6's card.
>
> Next is Don*. He too has trouble with 1/2 + 1/2 being a whole. . . (E, 2/3, 93-126)

At the close of her first day in the classroom, the classroom teacher asked Mrs. P. to help answer the question from children in the teacher's group about why 6/9 does not come after 4/6 instead of 8/12's in the following series of numbers in fractional number lines from the textbook 2/3 = 4/6 = 8/12 = 12/18 = 16/24. Mrs. P. explained that the order of fractions was arbitrary and used pattern blocks to demonstrate fractional equivalents (E, 2/3, 183-223). At the end of the day, Mrs. P. and Ms. W. discussed plans for a workshop for the children on number lines; this was to be provided by another math specialist, who had a master's degree in mathematics, and was perceived by others as providing instructional leadership, informally, to the group of three math resource teachers.

The next day, the MPS added a picture of the pattern block representing each fractional part to the symbolic representation of fractions on the cards in the game of One. With this "visual aide" children were more successful playing the game indicating a mastery of the concept of fractional parts equalling a whole on the representational level but not on the symbolic level.

Day 8. "One" with Visual Aids

> . . .Katherine begins. She has one whole and sets it down: 2/6 + 2/6 + 1/6 + 1/6.
>
> As the game continues, the students show much more understanding of the game objectives. P. helps very little as compared to yesterday; at least one whole pattern was put down by each player without being told. . . (E, 2/4, 21-29)

The MPS also provided bilingual instruction to Linda, a monolingual student.

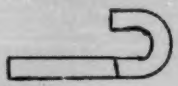
Day 8. Bilingual Math

> . . .Linda is in the group, so P. gives an explanation of the game "1" in English and in Spanish. Alice is puzzled by their ability to communicate in a foreign tongue. . .
>
> When it is Linda's turn to play, she and P. interact in Spanish. But, at P's request, Linda does give her "whole" card combination in English: 1/6 + 4/6 + 1/6. . . (E, 2/4, 61-65, 71-75)

On the last day that the MPS was in the room, the classroom teacher worked on strips of paper and fractional numberlines with the part of the group that was not meeting with the MPS. The MPS group worked on an activity sheet using pattern blocks, and fractional parts of the sixths family, which the students seemed to understand and finished the task independently. A major point of the lesson is to learn that each fractional part is proportionally equal.

Day 9. . . .Ms. W.: Picks up a red strip.
Ms. T.: This is called what?
Sts. : 1/2
Ms. T.: 1/2 + 1/2 = a whole.
How many 1/4's?
Sts. : 4
Ms. T.: So you divide your strip into what?
Sts. : fourths.
Ms. T.: 2/4's + 2/4's

Now go to the third's strip. Find the number that is 2/3's. Is that 2/3's



Sts. : yes
Ms. T.: I'd like a number line of 3/6's.
What do you do first?
Sts. : Fold into sixths.

Other examples for folding were given.

Ms. T.: Go back to the brown strips. You want a number line for 2/3's, what do you do first?

P's group leaves. Pete didn't play.

Ms. T.: Fold strip into thirds, 3 equal pieces. Troy*.

Troy is called up to demonstrate. Ms. W. re-illustrates.

P. calls for a new group: Will, Katherine*, Thomas*, Jake, Don* and Roberto*. Pete wants to join this group, but is asked to leave.

P. hands out first puzzle. (Page 31, refer to handout.) The students are to cover the hexagon with six blocks. They choose six green triangles. P. asks, "Why not red?" Students reply, "Wouldn't fit." P. says it is 1 piece or 1/6; 1 of how many equal pieces? - 6. Equal is the important word.

She asks that they clear the board and move on to 1/6. She asks Will why he used one triangle. Will replies, "1/6 out of a whole."

P. says, "I'm going to ask something tricky. Can you find another piece which equals 2/6's?" Students say, "the blue diamond." P. asks, "How can you prove it?" She calls on Jake, but says "Danny" mistakingly. Jake puts two green triangles on top of the blue diamond.

For 4/6's P. has the group work independently while she helps Jake.

Roberto* looks for help from other students and P. (I don't believe he could read the directions.)

When they get to 6/6's, Thomas* says it can be 1 whole, two 1/2's or three 1/3's. P. commends him.

They're going to try a harder puzzle. (There's a woman at the door and the lesson stops momentarily.)

P. tells the group they must share the blocks, so all blocks are moved to the center.

(Number 1) of the exercise (page 33) asks for a star of blue blocks. While the students are working they share small talk - sports, etc.

P. tells them to save the blue star; push it in front of them.

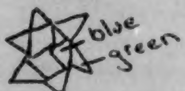
P. asks: how many blue did it take to cover the star? Thomas replies: 6.

(For number 2) P. asks: how many green were needed to cover the star? Students reply: 12.

(Number 3) asks for 3/6's blue and 3/6's green. Katherine* picks this up quickly.

P. must assist Jake and Will*.

A few came up with creative designs which P. commends.

Danny: 

P. asks them to pile the green on top of the blue to see that they are equal.

She tells them to go on to 4 while she helps Jake. Thomas reads the directions and does the problem right. Will copies. I'm not sure about Katherine. But when asked how she knows they're the same size pieces, she demonstrates by piling the green on the yellow hexagon.

The puzzle exercise is over; they did not do number 5. P. commends Roberto* on doing a super job. He hops back to his desk.
(E, 2/5, 68-182)

Observations Following the Mathematics Project Specialists' Direct Services

After the MPS left the classroom, the classroom teacher continued with teaching fractions concepts from "one whole" to 25/25's, and began instruction on adding, subtracting and dividing fractions. A measurement activity using protractors to divide a circle into equal parts, was used to further develop concepts. Math games were not observed, nor was grouping for math. A quick review of children's ability to add fractions suggested students understood how to do this.

Day 11. . . .Ms. W.: I found out you know how to do 25/25.
(T) It's a big number. And I saw how you can take a circle and use tools to break it down. Julie, you got 8/25, and Carmen you got 1/25. What is the total?
Julie : 9/25.
T : Alice, choose two people and add their numbers.
Alice : Pam?
Pam : 2/25
Alice : Kim?
Kim : 2/25
Alice adds 2/25 + 2/25 = 4/25's.
T : James, why not add the denominator?

James : Only 25.
T : Only 25 pieces. Troy? Is the numerator on the top or bottom?
Troy* : Top, it's smaller.
Pete : Denominator tells how many pieces.
T : Troy says the top number has to be smaller than the bottom number.
Briggs: It can be the same.
T : Can it be bigger?
Sts. : Yes. No.
T : Can I write 28/25?
Brenda: No.
Pete : Yes.
T : Why? Tomorrow we'll talk about it.
T : Briggs, choose 3 people and add their fractions.
Briggs: Pete?
Pete : 5/25.
Briggs: Alice?
Alice : 8/25.
Briggs: Carmen?
Carmen: 1/25.
T : How much Thomas?
Thomas*: 14/25.

A different activity, that of asking students to divide squares into equal fractional parts could be done by most (E, 2/12). Students drew, cut and folded to complete the activity.

On the last observation day the teacher presented a whole group lesson using Cuisenaire rods to solve worksheet problems on fractions, titled "Some Structural Play." During the first activity a question arose regarding whether or not the value of the rods could be changed from 10 to 12 in solving a fraction problem (no base other than 10 had been observed during the entire study). In the ensuing discussion it was decided to not change the value of the rods.

Day 15. . . .Ms. W. : Kim, how do you write four light greens as a fraction?
Michael: 4/4's/
T : Yours Julie?
Julie : Six reds; 6/6's.
Pam : I used 12/10's.
T : Look at c. It's called what?
Sts. : 10/10's.
T : How many?
Sts. : 12
Briggs : It'd be 12/12's. It takes 12 to make a whole.

T : Perhaps it's no longer a tenth,
we rename.
Briggs: Yeah.
T : Brenda, what do you have?
Brenda: I don't have enough whites.
(She picks up more.)
T : Now what?
Brenda: 12/12's.
Ms. W. and I questioned renaming tenths to twelfths.

T : Otherwise, you'd have to rename all
the rods. (E, 2/16, 20-43)

In the independent work on these activities some of the children succeeded while others did not attend to the task.

Summary

This report only briefly presents some of the more salient features of the math program in classroom E which appeared in the protocols and which could be intelligible to a reader. Only a complete reading of the protocols can convey the situation created by the multiple pullout programs in the classroom. Children left and returned quietly but often needed teacher attention to reenter instructional activities in the classroom. Often this happened two, or three times during instruction.

In the first two weeks of the unit on fractions, during which she attended a workshop on fractions, the teacher provided a number of activities based on paper strips representing various fractional parts and several games. Games appeared to facilitate children's thinking and problem solving and were used as an instructional tool rather than for maintenance. Students were usually grouped into 3 or 4 groups during the activities portion of the class period, which took the major proportion of the time, and later given whole group instruction to summarize what was covered. The children made some of their own material, e.g. folding paper strips into a specific number of fractional parts, and sometimes the mathematics activities lasted for a long time, e.g. 2 hours.

When the mathematics project specialist (MPS) entered the room, during the third week of the unit she provided supplemental activities on fractions designed to build the concept of adding fractions to make up a whole. The MPS used three dimensional manipulative aids and "One," a card game with written symbols, e.g. 1/3, 2/3, in instructing small groups of mostly target students. It appeared that while the low achieving students understood the concept at the manipulative level, they did not understand adding of fractions at that point well enough to play the game without adult assistance. After the MPS left, several children showed interest in playing the game of 'One' again. While the MPS was in the room the teacher was attempting to explain fractional number lines from the textbook and asked for assistance from the MPS in explaining the reasoning behind the specific pattern of fractional increments of two-thirds used in the textbook which jumped from multiples of three to multiples of 4 (the textbook pattern was 2/3, 4/6, 8/12; a high achieving child wanted to know why 8/12's was used, not 3/9). Since fractional number lines appeared to be a potential hurdle for the entire class, a possible math workshop for the class was talked about; (subsequently the mathematics project specialist decided not to do this).

After the mathematics project specialist left the classroom, the classroom teacher continued the unit on fractions, expanding it to addition, subtraction and division of fractions. Paper strips divided into fractional sections of fractional number lines. Mostly whole group instruction was observed at this point.

This was a classroom with a wide divergence of achievement levels among the students, with a small group of higher achievers (about 6) and a larger group of lower achievers. The small group activities, using visual representations of concepts and providing more individualized classroom teacher (and MPS for a few days) verbal interaction, and peer group interaction, seemed particularily beneficial for low achievers who did not participate as actively in whole group instruction. On the other hand, recitation organized whole group instruction may have been stimulating and important to the progress of the higher achievers. Towards the end of the study, both target and nontarget students demonstrated mastery in their oral responses to addition of fractions with like denominators. The classroom teacher planned to test students to evaluate the unit in the week following the observational study.

Study E

Observation Schedule

Date	Day	Hours	Minutes
1/19/81	Mon.	2	30
1/20/81	Tues.	Cancelled*	
1/21/81	Wed.	1	
1/22/81	Thurs.	2	45
1/27/81	Tues.	2	20
1/28/81	Wed.	1	20
1/28/81	Wed.	1	15
1/29/81	Thurs.	1	
2/4/81	Wed.	1	
2/5/81	Thurs.	1	10
2/9/81	Mon.	1	50
2/10/81	Tues.	1	
2/11/81	Wed.		45
2/12/81	Thurs,	1	20
2/13/81	Fri.	1	
2/16/81	Mon.		50

TOTAL - Days: 16 Hours: 21 Minutes: 25

*Cancelled observations are included but are not counted in the total number of observation days.

Classroom Ethnography Case Study
for Research Site F

Context of the Research Setting

When the observations began in late January, the class was just finishing the Division unit in their math textbooks. The plan was to observe four math sessions the week before, four during, and at least four (eventually 6) following the Math Project Specialist's (MPS) involvement. The MPS would be introducing the concept of fractions to the class, using materials demonstrated at the math inservice (1/22) which Mrs. Franklin, the classroom teacher, had attended. That workshop had been her first this year, due to health problems and a move from one school to another.

Mrs. Franklin's classroom (mixed 4/5 Grade) spanned a wide range of ability levels. There were 9 math target children out of a total of 28. In math, the children were generally working in the textbooks for their official grade levels, but on the same topics. For this introduction to fractions, no distinction between grades would be made.

All but three of the children (_all_ target children) were bilingual Mexican-Americans. Mrs. Franklin, however, spoke little Spanish. Though the parttime teacher aide, Mrs. Perez, was bilingual, and often interacted with the children in Spanish, the classroom was formally monolingual, English only. All teaching materials, printed instructions, and assignments were in English.

Organization of this Report

This report describes periodic observations over a four-week time span of a classroom mathematics program. Major points are illustrated by excerpts from protocols written for each observation day. These are indexed by study identifier letter, date of observations and protocol page number. All names are fictitious but do reflect ethnicity for the most part. The names of Title I project participants are marked with an asterisk.

Pertinent names are:

Mrs. Franklin	Classroom Teacher
Mrs. Perez	Classroom Aide
Mrs. Jones	Title I Mathematics Project Specialist

Mark, Sylvia, Miguel, Ricardo, Ben, Marta, Tommy, Jo Ellen, and Roberto were target students.

First Observations: Before the Mathematics Project Specialist Involvement

Mrs. Franklin's classroom was located in a comfortable middle-aged school which seemed like an oasis in its arid working-class neighborhood. The room was colorful, decorated with the children's work, and arranged for flexibility. There were no desks; the children kept their things in cupboards at the back of the room. For certain purposes there were assigned seats, at the tables, but for the most part the children were free to choose their own places and companions, unless this became disruptive. Whole-group meetings were held on a large rug. (See diagram in Appendix .)

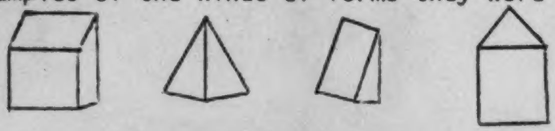
There was a regular schedule of activities each day by subject area, with math assigned an entire hour. In addition, there were several math-related activities presented during the daily "centers" time, when the room was organized into seven centers. During centers, the children chose from among these areas according to their preference, but they had to complete all seven within a week and could not "repeat" until this was accomplished. During centers the room had the feel of a busy workplace, with the children working and chatting at the same time. Examples of activities available during centers showed an awareness on the part of Mrs. Franklin of the importance of concrete, manipulable math-related tasks even at the 4/5 Grade level.

Day 1 (F, 1/26, p. 2-3)

The math tables were:

Pattern Blocks: There were more children at this table than at any other. Mrs. Perez said, "They always try that first." The directions were to line small wooden pattern blocks up on a sheet of graph paper to make designs or pictures, draw around the design with a pencil, and then color with crayons. This table, and the Solid Shapes table (shown on the following page) were centers of social behavior as well as "schoolwork." The children were talking about the class "social scene" as they worked on their pictures; it was reminiscent of a bridge club, in which the interactions are of equal importance to the game. A good place to eavesdrop.

Solid Shapes: At this center there were sheets of construction paper printed with geometric shapes. The directions were to cut out the shapes and use them to tape together a solid geometric form. There were lots of examples of previously-made shapes to copy, or the children could make up an entirely new form. It was up to them to figure out what would work. This, like the Pattern Block area, was math-related, but also a creative process which could expand to fill an indeterminate amount of time, and also a talk-while-you-work activity. One girl asked Mrs. Perez for help in getting started on this; Mrs. Perez responded by reading the directions (English only in this classroom) in Spanish. The children in this center and in the Pattern Block center, worked almost entirely independently, however, for the rest of the session. Examples of the kinds of forms they were creating:



The second observation shows Mrs. Franklin's math teaching style during the textbook-based daily math period. The target children and others who needed "help" sat at tables close to the blackboard where Mrs. Franklin was writing each problem. The children who could do the work independently sat away from the blackboard and did not have to attend to Mrs. Franklin's presentation. Though she did not actually use concrete objects, Mrs. Franklin asked the children to imagine that division was "removing sticks."

Day 2a (F, 1/27, p. 3)

Mrs. Franklin asked Mark* to read the first problem aloud. Roberto*: "That's a simple one, Miss." Mrs. Franklin wrote the problem on the blackboard; this is how it looked when it was finished:

```
       40
    ------
   |  364        10 x 9 = 90    (1)
 9 | - 90
   |  274        10 x 9 = 90    (2)
   | - 90
   |  184        20 x 9 = 180   (3)
   | -180
   |    4
```

The method she used went like this: For step (1) she asked how many bunches of 9's they could take out of 364. Could they take out 10 bunches? "Let's try it." She called the bunches of 9's "sticks" and asked the children to imagine transferring these bunches from the pile of 364 over to Ben's table. Step (2) was the same. Then she said, "Look--we've taken out how many in all?" (180) "Can we take 20 9's out this time?" (Step 3) And it worked, with a remainder of 4. The 40 came from adding up the 10 + 10 + 20 bunches of 9's. Miguel*: "Miss, can't we go on?" Mrs. Franklin: "Well, you're smart; you can figure it out by yourself." But then Miguel* called out "Miss, leave it up there!" when he saw Mrs. Franklin was ready to erase the problem. He quickly copied it on his worksheet.

Miguel*, who was removed from has table for being disruptive, still continued to participate from his seat on the rug. In fact, this session was marked by active participation from the target students.

Day 2b (F, 1/27, p. 6-7)

They began the last problem:

$$\begin{array}{r|r l}
 & 80 & \\ \hline
 & 560 & 50 \times 7 = 350 \\
7 & \underline{-350} & \\
 & 210 & 10 \times 7 = 70 \\
 & \underline{-\ 70} & \\
 & 140 & 10 \times 7 = 70 \\
 & \underline{-\ 70} & \\
 & 70 & 10 \times 7 = 70
\end{array}$$

For the first step, Mrs. Franklin suggested that they take out 30 7's instead of just 10. Miguel* yelled out: "50, Miss!" Mrs. Franklin: "OK let's try that. How many would that be?" Miguel*: "475!" "560!" There was growing activity and talking in the back as those children finished their worksheets. Several approached Mrs. Franklin with questions. She aimed a loud "SHHH" at the back of the room. Roberto*: "It's 350, Miss, because I already started it!", and then, "There's no remainder. I got it already!" Mark* said, "The remainder is 0." Mrs. Franklin replied that if the remainder is 0, you don't have to put it down. She asked the group: "Think you can do it now? It's due tomorrow."

On the third day, in another "centers" observation, the Ethnographic Assistant (EA) noted that the children, especially when only one teacher was supervising, could use centers time to meet their own needs. It was a very indirect way of reinforcing math concepts, and sometimes there was no time for the teacher by herself to keep track of all the independent activity. In addition, some of the target children sought approval by calling the teacher's attention to their accomplishments, while others found keeping a low profile more satisfying.

Day 3a (F, 1/28, p. 4)

> Marta* and Margaret announced "We're finished." and went to the Writing table to report this to Mrs. Franklin, Margaret trailing behind Marta*, who did all the talking for both of them. They put their completed worksheets on the desk and looked through a file folder for something which they couldn't find. They took the folder to Mrs. Franklin. She found them another worksheet in the folder, and they returned to the couch to work on it. Mark* in the meantime, had finished his pattern block design, a very symmetrical design of hexagons. He mounted it on a piece of construction paper with glue and put it in a folder on the desk. His movements were precise and his work, very neatly done. He usually shared his work, beaming, with Mrs. Perez or Mrs. Franklin before he handed it in. This seemed to be a pattern with Marta*, also. Most of the other children simply finished their work and filed it. I walked back to the Solid Shapes table to see what Ricardo* and Tommy* had been working on for the past half-hour. They had developed a creative variation on the solid geometric shapes: coffins. They were just finishing the coffins and starting on the bodies to go inside, all made out of geometric shapes. They were working steadily and quietly, not drawing anyone's attention to their creation.

Two factors concerning centers, were that (1) the math tasks presented were not always in the same form as those presented in the math lessons (e.g. two different methods of division); and (2) if there was no time to check over their work, the children might actually be practicing errors.

Day 3b (F, 1/28, p. 8)

> Marta* and Margaret showed me that they had completed about half of their third math worksheet, more division problems. I looked to see if they were using the "take out" method Mrs. Franklin had used in the lesson the day before. It didn't look like it, unless they were doing that operation in their heads. The problems looked as if they were done "conventionally." Some of the answers were correct, but some were not even "close."

Day 4 of the observations found the teacher Mrs. Franklin preparing for the following week's shift in topic.

Day 4a (F, 1/29, p. 1-2)

> Mrs. Franklin said she had an announcement to make: that their work on division in math was over, and they were going to start a new topic, fractions. "I need to know how much you know about fractions." She asked them to get a pencil and put their books away. She passed out copies of Fraction Test I, which has been mentioned at the workshop. As soon as she got her test, Marta* piped up: "Mrs. Franklin, I know what the second one is!" Mrs. Franklin did not acknowledge this. She told the children to get quiet, to do their own work, to cover up their work, and not to copy from anyone else. "These papers are not testing you. I don't expect you to know much about this, but I need to know what you know." Roberto*, Tommy*, Miguel*, Ricardo* were sitting together at the "Solid Shapes" table, behind the screen. There was some activity and talking there as they got out their math books and set them up as "screens" to hide their papers. Mrs. Franklin asked Miguel* to move to another table. He complied, but very dramatically and noisily, kicking a chair out of his way, looking at her. Mark*, who was sitting at a table with Rena, was hard at work. Mrs. Franklin reminded him to cover his paper, so he hunched down over it with one arm circled around it, so Rena couldn't see. Rena had a question, to which Mrs. Franklin answered, "If you don't know how to do it, just don't do it." Sylvia*, Marta*, and Margaret were sitting together but not consulting, as they usually do.

As at some of the other research sites, one textbook test (pre and post in this case) would be one criterion for the success of the Title I program intervention. The test-taking situation was the only time in which collaboration was really discouraged. Generally, this classroom was noted for children-helping-children. It thus provided opportunities for the EA to eavesdrop on negotiations, joint problem-solving, or disagreements about the math assignments which illustrated how the target children were thinking.

Day 4b (F, 1/29, p.5)

> I finally figured out that they were disagreeing about whether to do the problem the "take out" way, or the conventional way, just putting a 2 over the 47 and

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> multiplying, etc. They took their papers to Mrs. Franklin for advice. She said, "There are two different ways to do it." She advised Roberto* to stick to the take-out way, for now at least, although Tommy's* was OK. She pointed out that Tommy* was coming out with an answer of 2 R 15 while Roberto* was getting the right answer, 20 R 15, with the take-out method. She said that if they both did the problem right, with either method, they would get the same answer. Roberto* asked, "Can I do it that way, too?" (i.e. Tommy's* way) Mrs. Franklin: "If you know how. I wish you would stick with our way." Tommy*, to Roberto*, as they return to their table: "That's how my mom showed me. See, it's the same thing. You should use the short cut." I looked at Miguel's* paper. He had 20 as the answer to this same problem, with no "work" showing. I asked him how he got it; he said "In my head." Tommy* pointed out that he still needed the R 15. Roberto* and Tommy* continued talking and laughing about how they had gotten the same answer, though I noticed Tommy* still had 2 instead of 20 for his. It was 1:30. One problem done, but they seemed satisfied and even excited with what they had discovered about methodology in division.

Second Week: Collaboration Between the Classroom Teacher and the MPS

The Math Project Specialist, Debbie Jones, met with Mrs. Franklin on Wednesday, January 29. They planned for Mrs. Jones to be in the classroom the following week, February 2-5, in both the instructional groups, from 9-10 a.m. and the math centers, 10:15-11:15 a.m. Mrs. Franklin had changed her math instructional period to the morning because her aide, Mrs. Perez, was now in this room in the afternoon only. Mrs. Franklin felt it was more necessary to have an aide present for language arts than for math, so she switched the two subjects in her daily schedule.

In collaboration with Mrs. Franklin, the MPS planned to instruct 2 groups of low achievers, including all the target children, in fractions. They would focus at first only on the eighths family. She, also at the teacher's request, would prepare independent activities for follow-up and an outline of her lessons so that Mrs. Franklin could work in parallel each day with the nontarget students.

Due to a conflict in the EA's schedule, the Principal Investigator (PI) completed two of the four observations of the MPS in the classroom. The first one, from 2/2, shows the MPS asking the children to think of their old familiar pattern blocks in a new way.

Day 5a (F, 2/2, p. 1-2)

Mrs. Jones, the MPS, asked the group of 7 children to repeat their names at the beginning of the lesson on the equivalency of fractional parts. Pattern blocks were used for the lesson and the query "Can you find 4 pieces of the same color to cover the square?" was asked by MPS and classroom teacher in different parts of the room, unnoticed by the other. (This was due to the sharing of teaching instructions.) The classroom teacher also worked with a group of seven. When a child performed the task, the MPS emphasized the rules.

MPS : Do they follow the rules? Are they the same color? Do they cover the square? Are all of the pieces the same size?

Sylvia*: Can you prove it?

MPS : Prove it by laying it on top of each other.

9:15 (The MPS independent group of children was working quietly. The aide walked up to the observer and said three children are through and she has to get them something else to do--so she got another worksheet for the children.)

MPS : Now you are all so smart, lets see if you can use 8 pieces and cover the large red square?

Rena ; I don't got 8 pieces.. . .

MPS : If this was a cake (2 pieces) what part would be the whole cake?

Student: One third.

Not only that, but they were to learn new ways of talking about the pattern blocks.

Day 5b (F, 2/2, p. 2)

As part of the lesson, the MPS is attempting to teach the children the language of fractions.

MPS : Show me two fourths or two of four pieces. . .hold up 2 of the 4s. (Children have same shapes but same sizes are different colors.)

MPS : How would you identify that one is smaller? How would you say it? . . .

Several Students: 1/4 is smaller than 1/2.

Student : The 1/2 is bigger than the 1/4.

9:30 (A second group of three students walk over to the aide for help on worksheets with multiplication facts.)

MPS : One fourths, one eighth. What can you say about that?

Student : Two can cover one.

Each day the MPS and the teacher followed the same pattern of dividing the classroom in half and then dividing each of these groups into an instructional and an independent group. The MPS had brought along worksheets to occupy the independent groups, though sometimes there were a few difficulties with managing certain groupings of children and the timing of the activities.

On her second day Mrs. Jones, the MPS, presented one group with a "fraction-folding" exercise.

Day 6a (7. 2/3, p. 1-2)

Each child received a gold strip of paper, about 1" x 6". Mrs. Jones told them to write a 1 on the strip. Miguel*, one of her "independent" children, was up and walking about. Mrs. Jones told him to go and sit by himself, something Mrs. Franklin has done with him before. He promised Mrs. Jones he would stay put this time; her tone had sounded very firm. She turned back to her group and passed out some purple strips. Tommy* started writing a 2 on his, before she could stop him. She had them fold this strip in half. Rena asked "Why, Miss?" Mrs. Jones said to open the strip up, and see how many sections there were. Rena said, "Oh, I get it." Mrs. Jones said that each section was "one of two," so they should write 1/2 on each section. They stacked the purple strip on top of the gold one. Next came a pink strip. Mrs. Jones: "What do you think we're going to put on it?" Marta*": "One fourth" Mrs. Jones: "Then how many times will we fold it?" Marta*, almost predictably: "Four times." Mrs. Jones had them fold the strip once and

> then again, asking "Now what will we have?" Ricardo*: "One third." Tommy*: "One fourth." Tommy* supplied the rest of her instructions: "Write one fourth in each square."

Then she moved gradually from one concept level to the next. from simply identifying fractions to comparing them.

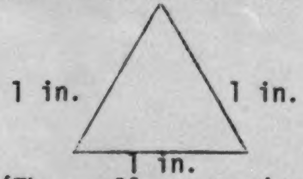
Day 6b (F, 2/3, p. 3-4)

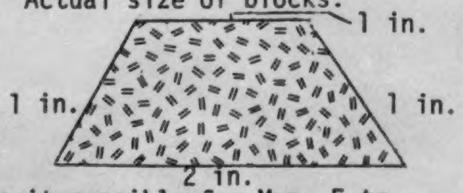
> Mrs. Jones had gone on to the next step in the exercise, having the children "show" her fractions by folding the strips. For instance, she said, "Show me the fraction 3/8 by folding the family of 1/8's" or "Get your strip of 1/16's. Show me 4/16's." Tommy*, again the first to respond, said "Like this, Miss." (holding up his strip) Mrs. Jones said, "OK if you're so smart, here's a tricky one. Fold the 1/2 strip back so you can only see 1/2. Then fold the 1/4 strip back so you can only see 1/4. Tell me something about these two." Margaret (her first response): "One's smaller." Mrs. Jones: "Which one." Tommy* and Marta* in unison: "1/4". She asked them to fold the 1/4 strip so they could see 2/4's. Marta*: "That's the same, Miss." (comparing it with the 1/2 strip) Mrs. Jones: "Marta, you stole my thunder! Now we can say 1/2 = 2/4." She had the children generate more equivalencies by folding the strips and comparing.

The PI completed the third observation of the MPS in the classroom. She noted improvements in organization and discipline since the first day. It appeared that the small group size, made possible by the team-teaching structure Mrs. Jones and Mrs. Franklin had devised,made it possible for them to give lots of help and thorough instruction in using the manipulable materials. Mrs. Franklin worked with a group on a pattern block exercise.

Day 7a (F, 4/4, p. 2-3)

> Two different colored blocks of different sizes were were used in this lesson. Actual size of blocks:

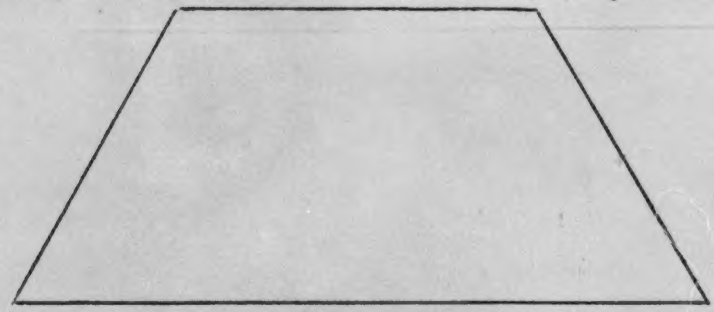




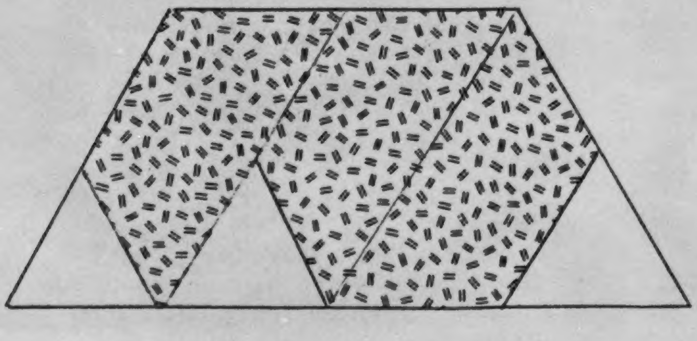
> (The small-group size made it possible for Mrs. F to help the children solve the problems that were presented through the worksheets. This help appeared critical at this stage of learning, as seen in the following observations.)

The worksheets contained various shapes that were to be divided in various fractional parts, Page One being to divide the shapes into 1/2 red and 1/2 green. One boy, Paul, covered the first shape with three green peices and three red peices. (As had been observed in the followup activity on Monday, using a different worksheet, many of the children were interpreting dividing into fractional parts as that number of parts, e.g., four for fourths, 2 of halves, but they did not have the concept that all of the parts should be equal in size.) The teacher asked Paul, "Can you cover the red with the green?" The child couldn't and then with the teacher's help worked out a visually more complex, but correct, solution. After checking the accuracy of the new design by putting green blocks on top of the red, the child asked, "But how do you color it?" The teacher answered, "Just as it is." The child removed the green and traced around the red in order to finish the task which was to color 1/2 red and 1/2 green. Later, child difficulty in representing through their crayon drawing the complex figures, was again observed.

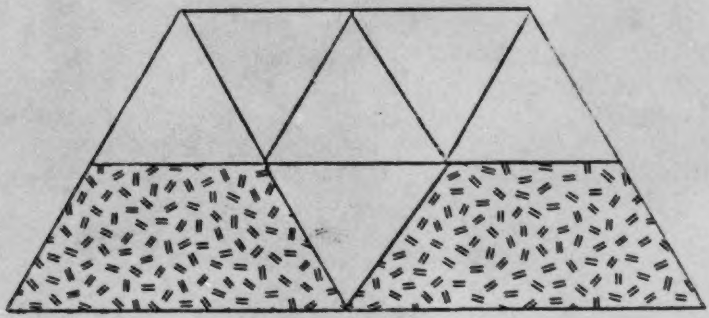
The shape to be covered with 1/2 red and 1/2 green was:



Paul's first solution was something like this: Figure 1



The second solution was: Figure 2



At the same time as this teacher-student dyad were working together, another boy across the table was doing his worksheet wrong. He was not attempting to get help. Another child, a girl sitting across the table, who had completed her worksheet correctly, was holding her hand up for five to ten minutes trying to get the teacher's evaluation. This child apparently did not know how to checkout her own solution and until after receiving the teacher's direct input would not continue on to the next page. (It seems that the children were mostly involved in their own thinking and were not paying attention to the teacher helping other children at the table--it was an individualized activity with one-to-one help even though all were seated together at one table.)

However, neither the teacher nor the MPS could completely "control" the follow-up activities assigned to their independent groups. On this particular day, this was the scene in the independent group area.

Day 7b (F, 4/4, p.4)

The group who had been with the MPS was now on the rug with new worksheets to complete. While pattern blocks were in a box on the rug for them to use, only one of five children had taken them out to use. In the main, the children were socializing about non-academic matters such as jesting each other about who "liked" who. Two girls, Raquel and Barbara from Mrs. F.'s group, were sitting on a small couch, with chairs pulled up to use as desks, at the side of the rug. They told the others that they had to do the worksheet first before playing the game. One of the boys answered, "We're not playing the game, do you think we're birdbrains?"

On the last day of her involvement the MPS, Mrs. Jones, introduced the game format for the first time, with the game "Roll-and-Remove." The preparation of the individual game "boards" and "pieces" had taken quite a while; one group never did get to the playing stage. The routine of "trading" in the game had the most relevance to the week's fraction lessons, as it indicated a real understanding of the comparative values of fractions (e.g. two 1/4's could be traded for 1/2).

Day 8a (F, 2/5, p. 4-5)

> Louisa rolled 1/4 and had to figure out that she could remove 4 1/16's. It was back to Gordon. He had 1/2 and 2 1/16's on his board. When he rolled 1/4, he had to trade his 1/2 in for 2 1/4's. The trading was the most important part of the game, because it demonstrated the ability to think in terms of fraction equivalencies. Ben* was singing a song about "Gimme gimme something good to eat," dancing in his seat. When he rolled 1/8, he said, "I don't have one." Louisa said, "Yes, you do. The orange one." Mrs. Jones asked him to please sing later, but he continued. The game was picking up pace as one child after another figured out the trading routine. When it got back around to Ben*, Mrs. Jones showed him how he could trade 1/4 for 2 1/8's. Mrs. Jones asked, "Do you see why the other children have been trading for just one?" (i.e., putting 1/4 back and only getting one 1/8 in return, since one would be removed, anyhow.) One child explained that you "put two on and take one off."

The game format generated excitement. Unlike the MPS's other methodical, step-by-step presentations, it was unpredictable. And there was a chance to employ strategy to "win."

Day 8b (F, 2/5, p. 5-6)

> Ben* rolled 1/8; he had a 1/2 left on his board. The rest of the group gave him suggestions on how to do this one. Angela said, "He needs four, Miss." Louisa said, "No, take three. You put one back." Angela rolled 1/8 and passed the dice. She had 3 1/16's on her board. Miguel* said, "You could! You could!" Ben had 1/8 left. He rolled 1/16, but passed the dice. Mrs. Jones asked him why. He said it would be easier to get 1/8 than 1/16. (Strategy) He rolled 1/16 on his next two turns. Mrs. Jones was chuckling softly. Ben* decided to remove 1/16 this second time.

On his very next turn he rolled 1/8, and moaned "Oooh." Mrs. Jones said it was time to pack up the games. She gave them the shape worksheets, and their individual dice.

Classroom Teacher's Follow-up

One important part of this case study was following Mrs. Franklin, the classroom teacher, as she continued to develop the fraction concepts the MPS has introduced. Follow-up really began when Mrs. Franklin and Mrs. Jones, the MPS, met after school on the final day of their collaboration. First they evaluated their four days together. This was the first time Mrs. Jones had worked in a symmetrical team-teaching arrangement with a classroom teacher. They agreed that more advance planning would have been helpful. They both said it was hard to time their instructional and independent groups. The independent group had to be kept occupied long enough so that the teacher could concentrate on the structured group. Mrs. Jones said that the MPS does not know which children in her group work best together when she decides to sub-group. She wished she had known more about the individual children and their behavior beforehand. In order to manage her two small groups, Mrs. Jones said she had decided to ignore children from the independent group who approached her with questions. She felt this was the logical consequence of not having listened to the instructions, and paying attention to them would disrupt her structured group.

Then Mrs. Jones and Mrs. Franklin turned to planning follow-up activities. Mrs. Franklin was going to continue with the worksheet/ game approach for a while longer before introducing the textbook fraction materials. Mrs. Jones helped her adapt some of the games from the inservice to the 1/16's family, and demonstrated some new cuisenaire rod games.

For the next two weeks, Mrs. Franklin tried dividing the class into an independent and a structured group during math. She was working alone, without an aide, so that juggling the timing and management of the two groups was sometimes difficult. She made maximum use of the materials the children had prepared during the MPS's visit; the children kept their Fraction-Folding and Roll-and-Remove games in manila envelopes which Mrs. Franklin called their "fraction kits." In this observation, the addition of the Roll-and-Remove games to a numerical card game took the target children "one step back" on the concrete-to-symbolic continuum, to a level at which they could understand.

Day 9a (F, 2/10, p. 2-3)

As it turned out, Mrs. Franklin would be plagued by the same "timing" difficulty that had bothered Mrs. Jones the week before. The independent group was finishing their worksheets, while Mrs. Franklin had barely had a chance to deal out the cards for the game: One (or I Can't Believe I Made the Whole Thing.) Angela had finished first and was standing by Mrs. Franklin'e elbow wanting to know what to do next. She told Angela to do her spelling or read a story. Back to the game: the children did not seem to be seeing which fraction cards they could add together to make "one." Mrs. Franklin had to coach each one through his/her turn. She asked them to get their Roll and Remove games out of their cubbies. She showed them that they could, by placing various squares and rectangles on the big square, see that 1/2 + 1/2 = 1, or 1/4 + 1/4 + 1/4 + 1/4 = 1. "How many make a whole?", she would ask. "Eight of those, Miss," answered Tommy*, and "Sixteen of these," answered Roberto*, thinking ahead. She asked the children to look at their cards to see if they had any "Wholes." Roberto*: "I've got 6/8, Miss." "Then how many more do you need?" "2" Mark* came up to show Mrs. Franklin that he had finished his worksheet.

Once she felt her instructional group had grasped the game, Mrs. Franklin left them on their own. But without her guidance the game deteriorated.

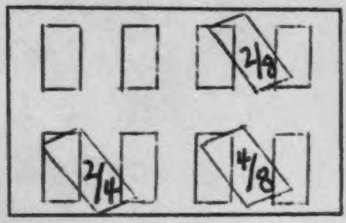
Day 9b (F, 2/10, p. 6)

Roberto* and Tommy* got deeply involved in a discussion about Tommy*'s cards. He didn't have exactly the right fraction to make a whole--what should he do? Roberto* said, "So start over." The game was getting lost. Tommy* left shortly to draw cars with Miguel*. Roberto* was very concerned with the dealing role; he was shuffling the deck a lot, not really attending to the players. But Margaret and Shanti continued with their own process: Margaret would read the fractions on the cards to Shanti, who selected the corresponding shapes to place on her board; Margaret was asking "Did it cover the whole square?" Margaret also followed Mrs. Franklin's pattern of laying the playing cards on to of the shapes. Sylvia* and Anita were using the same pattern, speaking in Spanish. Margaret read the fraction "2/4" to Shanti, who chose 2 1/8 squares to lay on her board. Margaret said "No," and removed them herself. "I said 2/4. Two of them." When Mrs. Franklin came by to see how they were doing, Roberto* looked up at her and said, "I already know how to play this game, Miss." But the logic of the "game" was gone, in that it was no longer a group effort, but partners working together with Roberto* supplying the cards as needed.

On Day 10 Mrs. Franklin worked with some of the higher-achieving children, who caught onto the same game very quickly, and were able to sustain the game on their own fairly well. On Day 11, Mrs. Franklin repeated the same game combination again with a group of mostly target children.

Day 11 (F, 2/12, p. 1-4

Today's structured group consisted of Jo Ellen* (who missed all the math sessions last week), Frankie, Marta*, Angela, Mark*, and Roger. Mrs. Franklin was using a combination of the One card game and Roll and Remove again. Mark* (who had played before) soon lined up his cards and shapes and saw that he had only 1/8 to go to make a whole. Frankie, too, was wanting one more card, while Marta* and Roger, new to this game, were still looking over their cards and shapes. Jo Ellen* had cards of all three denominators 1/2's, 1/4's, and 1/8's and looked confused about what to do with them. Angela joined Mark* and Frankie demanding another card from Mrs. Franklin, who said they would have to wait. She explained that they were going to have to take turns, with her checking over each player's hand to make sure they were getting the idea. She slowed down the pace, taking time to show everyone how Roger had 6/8, 3/8, and 4 1/8's. He could use his 6/8 and two of the 1/8's and keep the rest for his next turn. Mark* said, "Look, I could do it, Miss. 2/4 and 1/4 and then it takes 2/8 so I used all of them," as he lined up his shapes on the board. Mrs. Franklin introduced the idea of trading, showing Mark* how he could trade 1/4 for 2/8. Jo Ellen*, who had been absent all last week, was still moving her shapes around as if she were not sure what to do. She put her 2/8 card down with the 1/4 shape after watching Mark*'s turn, showing that she understood this equivalency. Then she added another 1/8 but this left her with a 7/8--too much, and 3/8--not enough. Frankie showed her she could use just the 7/8 and the 1/8 to make a whole, but she looked puzzled. Mrs. Franklin said, "How could you do it?" She showed Jo Ellen* that if she used the 3/8 + 2/8 + 1/8, there was no room for the 7/8. Frankie broke in and repeated how Jo Ellen* could use the 7/8 and 1/8. This whole explanation was rather hurried; other children were waiting for help. Marta* had been sitting quietly since the beginning of the game, with 1/2 and 3/8 on her board. She said, "You didn't check mine, Miss!" when she saw that someone was about to be attended to for the second time. Mrs. Franklin gave her one more card, which turned out to be 1/8, just what she needed. In the meantime, Mark* had gotten himself into a fix. Mrs. Franklin had made a remark that she wanted them to try doing their shapes in only one color, for some reason. Mark* had lined up his cards and shapes like this:



He said, "I got a problem, Miss Franklin. I didn't do it." Mrs. Franklin showed him he should use two 1/4 shapes for the 2/4, instead of 2 1/8 shapes. Mark* replied, "I thought I could only use one color." She said he could trade back the 1/4's for 1/8's if he wanted to. Marta* had 1/2 + 1/4 + 2/8. She called to Mrs. Franklin: "I need 4 more cards, Miss," to replace the ones she had played. Jo Ellen* was trying to figure out a way to squeeze 2/8, 3/4, and 2/4 on her board. Mrs. Franklin showed her she could do it with just the 2/8 and 3/4. Frankie was playing independently by now, showing Mrs. Franklin that he could freely "translate" from 1/8's to 1/4's, etc. in his explanation of his game plan. The Reading boys returned. There was a dispute over which worksheet they were supposed to do. Mrs. Franklin tried to settle the commotion by staying with her game group and directing a loud "Shhhh" in their direction, but finally she said, "I'm going to let Roger be dealer." As soon as Mrs. Franklin left, Roger was besieged with requests for cards. He had to give up his own game to attend to the other players. Mark* exclaimed, "I won!", but Roger showed him that he still needed 1/8--his cards were spread out to look like they covered the whole board, but when Roger shoved them over, there was space left. Jo Ellen* was playing with her shapes, stacking them up in neat piles. She had borrowed this fraction game from someone who had been present last week, so maybe she just wanted to make sure she hadn't lost anything. By 11:10 Angela was ready to give up on the fraction game, urging the other children, "Let's play Fish." Everyone started packing up their games and getting up from the table.

The disruptive return of the Title I Reading pull-out group at the end of the math period became a pattern. Mrs. Franklin's game and worksheet groups would both go fairly smoothly until the reading group came back. Moreover, the reading group were all math target students; the scheduling of math during their reading lesson, though it made the math lessons go more smoothly, meant they were missing most of the follow-up activities.

Mrs. Franklin gave the children a worksheet of fraction addition problems on 2/16, their first really abstract fraction task, after two weeks on this topic. They were allowed to use their fraction kits to work the problems. There was clear divergence between the performance of the target and nontarget children. Several of the target children had problems with adding fractions with unlike denominators, even though they seemed to have understood this in the game context.

The fraction unit stretched into its third week as Mrs. Franklin continued the game-worksheet format. She was gradually including more abstract or number-only activities, though encouraging the children to use their fraction "Kits" for help.

Day 13 (F, 2/25, p. 3)

> Marta*, Mark*, and Sylvia* were working together on the blackboard problems. Marta* said aloud, "One whole equals how many 8's?" She lined up her 1/8 shapes on the "1" square, and saw the answer, "Eight! Eight!" Sylvia* and Mark* filled in the same answer on their papers. Ben*, working by himself near the blackboard, was not using his fraction kit, but seemed to be doing fine. Roberto*, sitting near him, was on the third problem (many of the other children were finished). He asked, "What are we supposed to do?" as he shuffled the shapes from his fraction kit and played with the dice from Roll and Remove. Back with Marta*, Mark*, and Sylvia*: Marta* was asking herself "Ten sixteenths equal how many eights?" She gathered up 10 of the small squares and started lining them up on her 1/2 shape. Then she stopped when this didn't seem to work. Mark* simply counted out 10 small 1/16 squares on the table, and counted them by 2's to get the correct number of 1/8's. "It's 5," he told Marta*. Miguel* and Ricardo* were not doing the math problems; they were on the rug drawing monsters. I looked at the papers which had been handed in so far. Ben's* paper was all correct up until the last four problems, where he got either confused or hurried. For example, he had written 10/16 = 10/8. I didn't get to look at the other papers, as Mrs. Franklin asked the children to take them back to draw their picture representations on them. Juan asked me about the last problem--if it was really supposed to be 1/6 or 1/16 instead. Mrs. Franklin said it was a "tricky" one i.e., something new. Ther fraction Kits, based on 1/2, wouldn't help on this one.

Final Interview

The Ethnographic Assistant talked briefly with Mrs. Franklin at a math inservice in early March. Mrs. Franklin reported that when she finally introduced the textbook fraction materials, after four weeks with the manipulable materials, the class thought the text was "easy." At a later interview with the EA and the Principal Investigator, she repeated this and praised the Title I inservices. Her only frustration had been trying to utilize a two-group format without an aide to supervise one group. Otherwise, she rated the fraction unit as very successful.

Summary

This summary was based upon emergent themes suggested in Part One of the report on this project, plus some related themes unique to this site. Certain aspects of this classroom setting were particularly relevant to program implementation.

Ambiguity

This refers to the teacher and MPS's mutual understanding of their roles in the Title I math program. In this case, Teacher F and the MPS collaborated to develop a one-week introduction to fractions which would be only the start of an entire month's math lessons, based on a certain instructional model. The teacher perceived the role of the MPS to include planning for the week's sessions. She shared her lesson plans for her two small groups with the teacher shortly before the math period, so that the teacher could follow along in parallel with two other small groups. There was either an agreement or an assumption that the MPS would work with the target children (plus a few more to make half of the classroom) and the teacher would work with the other half. Teacher F is accustomed to a team-teaching approach, having always until this year worked with a fulltime aide. She seemed to enjoy the sense of accomplishment evident during the MPS's visit, and the opportunity to work with a small group, while someone she could trust was "in charge" of the remainder of the class. The MPS seemed to have no problems with accepting this kind of responsibility.

Conditional Collaboration

At the followup meeting immediately after the MPS's four-day visit (2/5), Teacher F said that she would have appreciated having the MPS's lesson plans further ahead of time, implying that this would be a new "condition" for future collaborations. Before the visits, she also had requested that the first week of fractions be limited to the 1/8's family. There was recognition at this same meeting that the MPS would be more effective if she came in for a preliminary visit before planning her series of lessons, to get to know the children and the setting.

The MPS did not, as pointed out, limit her responsibility to the five or so children directly involved with her at any one time; she took responsibility for the management of "her" half of the class and did not ask Mrs. F for assistance. At their follow-up meeting she mentioned some of the strategies she had devised for handling this.

Predominance of Classroom Organization

In the observations of Teacher F's own math instructional methods (F, 1/27, pp. 3-4 and 1/29, pp. 3-6), before the MPS involvement, she had employed a more "traditional" approach, presenting problems on the blackboard or assigning textbook lessons for the children to complete. It may have been that she had to adopt a more teacher-centered, whole-group method for math, since it was held in the afternoon when she had no teacher aide. In a preliminary interview, however, she said that she thought a measure of "basic" instruction was necessary to make sure all the children were evenly exposed to certain information they would need in succeeding years.

On the other hand, she allowed for more independent math-related activities during the daily, one-hour "centers" time (see observations for 1/26 and 1/28) in which the children had several days to complete a series of activities, several of which dealt with math concepts on the "concrete" level. (Emphasized in the MPS inservice workshops.) Teacher F also seemed to have materials in her classroom, such as pattern blocks and Cuisenaire rods, which other teachers at the fifth grade math inservice complained about not having. On one occasion at least she made a special effort to borrow enough cuisenaire rods from the other teachers in her school so that she would have enough for her class to use.

Teacher F was very disappointed that she had only been allowed a parttime aide this year, and seemed very receptive to the opportunity to work with another teacher in the classroom. Perhaps because of the observations, she also felt a commitment to "stick with" the teaching model she and the MPS developed. But after the MPS left, Teacher F had to struggle with maintaining order in both a structured and an independent group all by herself. Though the children in the classroom are acclimatized to independence through their experience with "centers," they still tend to drift without supervision (F, 2/10, p. 2 lines 24-25, and p. 3 lines 1-7, 18-25). See also 2/4, p. 4 lines 93-101.

Team-Teaching, Not Demonstration

During the MPS's visits she and the teacher worked independently of each other, i.e., the MPS was not serving as a teaching "model." The two seemed to be in complete agreement about what kinds of teaching strategies work best, and carried out their lessons very similarly, though Teacher F said she had to "ad lib" more when the MPS's plans were unclear. (See protocol 2/4 in appendix.) The MPS offered Teacher F her assistance and some supplementary materials at their followup meeting (2/5), so that Teacher F could plan a series of further fraction activities which would relate in some logical order with what they had done so far. The MPS seemed to be able to fit this sequence into a theoretical framework; that is, her interaction with Teacher F at this meeting had an "intellectual" quality as well as a practical purpose. The MPS emphasized not simply that certain teaching sequences work, but why they work. The MPSs, in general, function to provide teachers with this sort of analytical framework (see inservice observations 1/22 and 3/12). In this sense they do serve as models: for the integrations of theory and practice.

Teacher Evaluation of the Innovation

According to Teacher F, the children "scooted" through the textbook fraction unit easily after their experience with the related manipulable activities. This is important because for some of the target children "easiness" is a virtue. (2/4, p. 4 lines 5-6 and p. 6, lines 19-20; 2/12, p. 4, line 25 and p. 5, lines 1-10.) Like anyone else, they strove for feelings of achievement, not failure and frustration. The manipulative games seemed flexible enough to allow children at different levels of difficulty to learn as much as they were capable of. (2/10, p.3, lines 9-15 and p. 4, lines 1-7).

Teacher F rated the inservice workshops as excellent. She said that they helped her to know what services the MPSs could offer and therefore gave her a basis for structuring her collaboration with the MPS according to the kind of help she needed. She also said the students performed textbook fraction exercises well after developing concepts through manipulatives.

Themes Unique to This Classroom

Centers: "Centers," as already mentioned, was a daily one-hour period in which seven activity areas were set up. The children had a week or so to complete all the centers and recorded their progress on a chart. Some of the activities each week were math-related, though not directly related to the current math unit, e.g., pattern blocks, geometric solids or designs, graphs, dot-to-dot. One center--the Singer Lab-- was directly related to the current math topic. The Singer Lab was a box of programmed learning cards at progressive difficulty levels, divided into sections according to math operations such as "Addition," "Subtraction," etc. The child would look up a card with his/her name on it in a file box. This card would tell him/her which lessons s/he had completed so far, and which one to do next. The child would work on this during the centers period, and then clip his/her answers to the name card and refile. Teacher F would answer this "message" by recording the child's score on his/her card. This was the only center which had such a clear feedback loop. It was also the least popular, as it was the only center designated as "quiet," and the children liked to combine their centers work with social talk.

Too much paper was generated in centers for Teacher F to keep track of it all; she said there was no way she could possibly "grade" everyone's centers production. So centers for the most part was designed to offer the children stimulation but not to produce some measurable result on academic performance. The activities could fluctuate according to the teacher's or children's interests, holidays, seasons, etc.

One aspect of centers which is important to this study is the attitude toward their own learning it was supposed to foster in the children. One of the qualities Teacher F valued was self-direction. She felt that the training the children received in centers helped to make them more able to set their own goals and solve problems independently. Many of the MPS activities fit well with this sort of philosophy, as they emphasized processes rather than answers. The centers also provided the target children with multiple opportunities to succeed at their own pace, without evaluation.

Pullouts

A theme in this classroom which seemed to also occur in the other sites was the impact of the Title I reading pullout program on classroom routine. Teacher F could maintain a delicate balance between her structured and independent groups in the absence of the "Reading Boys," as they came to be called in the observations, but when they returned the balance was usually upset, (2/10, p.4).

Need For an Aide to Implement Program

As already mentioned, Teacher F believed that the ideas promoted by the MPS were praiseworthy, but required adequate teacher-child ratios for effective implementation. Halfway through the study Teacher F's parttime aide quit, and she managed with either no aide, substitutes, or new, untrained aides for the remainder of the year.

Production Orientation of Target Children

Some of the target children seemed to have a penchant for completing lots of work (1/27, P. 7, lines 24-25, and p. 8, lines 1-4; 1/28, p. 4, lines 8-14 and p. 8, lines 1-8; 1/29, p. 4, lines 3-9; 2/4, p. 4, lines 14-25, and p. 5, lines 24-25, p. 6, lines 1-3). It seemed important to their self-esteem to "get something done," whether that something were "easy" or "hard," though easy was preferrable. Both Teacher F and the MPS handed out many "worksheets." The MPS provided children feedback on the worksheets she assigned (2/3, p. 4, lines 4-11 and 2/5, p. 6, lines 15-17). Of course, she was working with only half of the group on only one topic a day, but this kind of one-to-one feedback would seem advisable to elevate the worksheet to a real teaching activity.

Conclusions on the Impact of the Title I Program at Site F

Because of Teacher F's commitment to the goals espoused by the MPSs, the level of cooperation between Teacher F and the MPS, and the orientation toward manipulable activities already existing in this classroom, the Title I math program seemed to have maximum impact, within the limits imposed by inadequate aide staffing.

Study F

Observation Schedule

Date	Day	Hours	Minutes
1/26/81	Mon.	1	10
1/27/81	Tues.	1	5
1/28/81	Wed.	1	10
1/29/81	Thurs.	1	
2/2/81	Mon.	1	8
2/2/81	Mon.	1	4
2/3/81	Tues.	1	10
2/4/81	Wed.	1	8
2/4/81	Wed.	1	5
2/5/81	Thurs.	1	5
2/10/81	Tues.	1	5
2/11/81	Wed.	1	
2/12/81	Thurs.	1	10
2/17/81	Tues.	1	5
2/2/581	Wed.	1	

TOTAL - Days: 15 Hours: 16 Minutes: 25

Classroom Ethnography Case Study
for Research Site G

Context of the Research Setting

This study began in late February and consisted of 11 observations carried on throughout the month of March. This was a third grade classroom in a large elementary school containing students from a wide range of socioeconomic levels and achievement backgrounds. The ethnic background of the students was Anglo (53%), Hispanic (30%), Indian (10%) and Black (7%); Title I target students included four Mexican American students and one American Indian student.

The classroom teacher (CT), Ms. R., had participated in the Title I mathematics inservices for two years; this was the first year she received classroom services. She said that the Mathematics Project Assistant (MPS) Ms. W. had been in her room several times this year and that she asks the MPS to initiate a concept with the children. When the MPS is finished she leaves followup activities for the teacher and aide to use with the children. The classroom teacher and MPS have a team teaching arrangement; however, the MPS does demonstrate teaching strategies for the aide, Mrs. L., who in turn tells the teacher what had gone on. The MPS had last been in the classroom in January.

The target students were not grouped in a separate group. When the study began one target child had moved and the teacher added another to the list. Several math target students went to the Title I reading program which was scheduled before the mathematics period from 10:30 - 12 during the study (math sometimes was scheduled for the afternoon).

The aide, Ms. L., was Mexican American and played a major role in this classroom. She was an experienced aide, having worked as a regular, daily classroom volunteer for several years previous to obtaining a paid aide job. The teacher and aide each worked with groups of students in the reading and math program.

Organization of this Report

This report describes periodic observations over a five-week time span of a classroom mathematics program. Major points are illustrated by excerpts from protocols wirtten for each observation day. These are indexed by study identifying letter, i.e., g., date of observation and protocol page number. All names are fictitious and do not reflect ethnicity. Names of Title I participants, e.g. low achievers, are marked with an asterisk.

Pertinent names are:

Ms. R.: Classroom teacher
Ms. L.: Aide
Ms. W.: Title I Mathematics Project Specialist (MPS) providing classroom services
Ms. P.: MPS
Ms. E.: MPS

Juan, Katie, Jackie, Al and Carrie were identified by the teacher as Title I target students.

Observations of the Classroom Mathematics Program Before the Mathematics Project Specialist Entered the Scene

Since this study took place late in the school year, the mathematics project specialist (MPS) had been in the classroom prior to the onset of the research study. During the six observations before those of the MPS in the classroom there was evidence that manipulatives were part of the normal classroom mathematics program. Some observations were of the teacher and some of the aide working with students in mathematics.

Mathematics lessons were one of five morning learning centers. Children had just been placed in 5 new groups by achievement level on the day that the observations began. Groups rotated between the teacher, aide, listening center and assigned independent work in language, spelling and writing.

The first observation showed the teacher working with small groups (6) of children on the rug. She was beginning a unit on multiplication and division facts of 1 and 2. The aide helped at the language center; she also disciplined students at their desks, so that the teacher's math lesson wouldn't be interrupted.

The teacher, Mrs. R., used Cuisenaire rods and graph paper in introducing the multiplication facts. An example of teacher-target student dialogue follows:

Day 1. . . .T : How many spaces does each red represent?
Sts.: 2. ☐☐☐☐ (graph paper)
T : How many rods did you use Kate*?
*Katie: 7.
T : How many spaces are represented?
Sts.: 2.
T : 7 x 2 equals what? *Katie?
*Katie: 14. (G, 2/25, pp. 6-7)

The next day the teacher taught language and the aide, Ms. L., worked with the math groups, using a handout and egg cartons with clear and orange beads. The following excerpt illustrates the aides instruction using manipulatives:

Day 2a. . . .10:40 Ms. L. had a new group.
L : Write your name on this sheet.
Don't write any answers 'til
I show you how. My problem is
3 x 2. I need 3 boxes (compartments).
How many beads?
Sts. : 2.
L : 2. 3 x 2 = 6. Now write the answer.
Bill : What if you don't understand?
L : Now, we'll do half the page together,
then you can complete it. Now a
division problem.
L : I could be 6 ÷ 2 = 3, or 6 ÷ 2 = 2.
Laura, you do the next one.
Laura: 1 box with 3 beads.
L : Alright. 3 x 1 = 3. Now a division
problem.
Laura: 3 ÷ 3 = 1
L : Bill, you're next. (G, 2/26, pp. 2-3)

The most common mistake made by the students was wanting to divide by one. Most students said three divided by one equals one but were told by Ms. L. to say 3 ÷ 3 = 1. Later Ms. L. explained that this was to help children learn the rules of division. An example of Juan and Jackies' performance (target students) follows.

Day 2b. . . .11:03 Ms. L. had a new group started. Juan* was in the group. Juan* went ahead and filled in the first two rows, but hesitated with "2 x 0." He went back to it minutes later and wrote zero. When called on to answer 4 x 1, he said "4," but made the common error of saying 4 ÷ 1 = 4. Bill corrected him with 4 ÷ 4 = 1. . .

Ms. L. called on Jackie*.
L : The number of boxes?
Jackie*: 8.
L : How many beads in each one?
Jackie*: 1
L : The answer?
Jackie*: 8.
L : Write the answer down. A division
problem?
Jackie*: 8...

L : Divided by...
Jackie*: 1
L : Can you divide 1 by 8?
Jackie*: No
L : So, 8 ÷ 8 equals what?
Jackie*: 1.
*Al was called on after a student gave the answer for 6 x 3.
L : Al*, do 5 x 2. How many boxes do you need?
Al* : 5.
L : And in each box?
Al* : 2 (beads)
L : The answer is?
Al* : 10.
L : Do the rest of you agree? (some do, some don't)
L : Let's try a division problem.
Al* : 10 ÷ 5 = 2
L : Ok, 10 ÷ 5 = 2, or 10 ÷ 2 = 5.
Neither Al* nor Jackie* got ahead of their group, but worked each problem right along.

I waited to see Jackie* work another problem before taking notes. Her problem was 9 x 2.
L : Can anyone tell me the answer before Jackie* finishes (counting the beads)?
Sheryl : 18.
L : Is that correct?
Jackie*: Yes.
L : Ok, give us a division problem.
Jackie*: 18 ÷ 2...
L : equals...
Jackie*: 9.
L : How else could you divide this?
Jackie*: 18 ÷ 9 = 2.

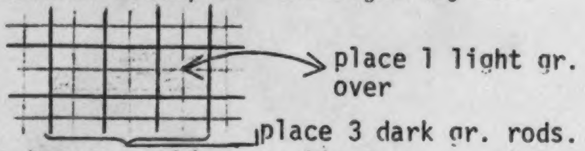
The next week, instruction continued to focus upon the multiplication and division facts, now extending into the "3's" facts. Cuisenaire rods, graph paper and a short facts test was used as part of instruction. Students readily used the cuisenaire rods representing 1, 2, 3 but became somewhat uncertain of the value of the longer rods. As a review of the rod's values, students made a staircase of rods from high to low. There is some indication that the learning of spatial relationships exemplified in patterns made with cuisenaire rods was a separate but parallel process to learning to write out the facts symbolically. Cuisenaire activities were done regardless of children's mastery of fact sheets.

The following excerpt describes the classroom teacher's lesson on multiplication and division.

Day 3a. . . .10:33 A new group of students joined Ms. R.
She handed out sheets of math work and told the
students to do the side with the plates. As
quickly as they finished, she graded the papers,
and told them to turn their paper over.
Ms. R.: Look at the first problem. What
block equals 3?
St. : Light green.
T : What block is 2?
St. : Red.
T : How many spaces do the green take
up? (on graph paper).
St. : 6.
T : There's our answer. 2 x 3 = 6.
Write your answer and put a
division problem below it. What's
yours Lex?
Lex : 6 ÷ 2 = 3.
T : Good, on to the next problem. (G, 3.3, p. 2)

A different pattern was made with cuisenaire rods associated with multiplication concepts (than previously used with addition-subtraction concepts).

Day 3b. . . .Bill: I can't get three on.
Maria: Look you're doing it wrong.
T : We're making crossroads not trains
today.
Bill made several attempts. The right way was:

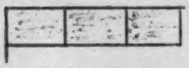


T : See how many whites or 1's you can put
on the dark green; 6's. (G, 3/3, p. 6)

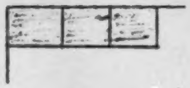
On the fourth observation day (3/4), the aide was absent and Mrs. R. taught the whole group another lesson on multiplication and division using Cuisenaire rods, graph paper and a handout. While some students were very attentive to the lesson and followed through using every step of the process carefully when working at their desks, classroom management was more difficult without grouping and the aide's help. Children were first told the number of rods in each color required for the lesson, and then graph paper was handed out. Children were instructed to number rows and columns. Mrs. L.

taught the children a technique for division by 1, 2, 3, 4 and 5. First students colored in enough squares to equal the number being divided, then the colored squares were covered with the rods representing the division. The number of rods required to cover all the colored squares represented the answer. Students were also shown the symbolic representation.

Day 4. . . .T : Ok, on this paper (graph) color in 3 squares



This is the number being divided, so we color 3 squares. Now, it's divided by what number?
Grace: 1.
T : Which block represents 1?
Grace: White.
T : How many blocks do we need to cover it up?
Sts. : 3.
Ms. R. wrote the problem on the south board. . .

①  $\begin{array}{r}3\\1\overline{)3}\end{array}$

I noticed Katie* stayed right along with Ms. R., coloring each square, always using the Cuisenaire rods first, and writing in each answer. . .(G, 3/4, p. 3-4)

During this week the teacher, aide and ethnographic assistant attended a mathematics workshop on problem solving, fractions, and graphing (3/5).

The next observation, 3/9, again showed the teacher having children use rods to learn multiplication facts, now including the 8's and 9's, and to apply them to problem solving.

Day 5. . . .Ms. R. began by asking each student to make a staircase. While they were building, she handed out the math sheet.
T : Does everyone have a staircase? Julie, read the story at the top please.
Julie read the story.
T : Mary is doing what Maria?
Maria: . . .putting out tires.
Ms. R. reread the question for Jake.
Jake : Do you put "3 t.?"
T : . . .put the whole word. The answer is "3 tires." For the first problem you are given the answer. What is it Maria?

Maria: 16.
T : 16 squares. Everyone put a dot on 16 squares.
They used the laminated graph paper.
T : You need to multiply two numbers to get 16. We know one. "Two" is what color?
Sts. : Red.
T : See how many red cover up 16 dots.
Sts. : 8.
T : . . .so, what goes in the blank?
Sts. : 8. (G, 3/9, p. 3-4)

The process of adding rows was used to assist students to derive the answer to the harder facts, e.g. 9 x 8. This adding proved very difficult for some of the students, including Juan, a target student.

The next day students had an opportunity to play "Bingo," a game designed for learning multiples of 1-9. If not playing bingo, students were at their desks, or having their language workbooks checked by the aide.

The rules of the game were as follows:

Day 6. . . .I entered the classroom at 10:30 finding Ms. L. at the west rectangular table with 6 students, playing Bingo.

Actually, each player had a laminated board with 1 and 2 place figures. The bingo playing pieces had multiplication problems on them. For example, "2 x 9."

Ms. L. drew a number from a small box. Let's say her number was "16." If the students found "16" on their board, plus used the correct playing piece, such as "2 x 8," they placed the piece on their board.

There were two "free" spaces and pieces for each player.

If a student said "Bingo!" he must read his problems back to Ms. L. For example:

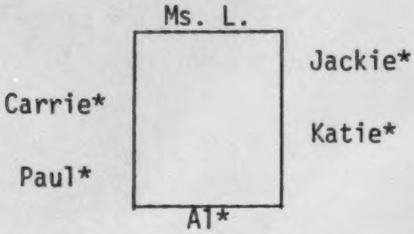
8 x 2 = 16
2 x 5 = 10
1 x 3 = 3
2 x 4 = 8
(G, 3/10, p. 1)

16			
	10		
		3	
			8

The students all appeared to enjoy the game. Those seated at the game table did not want to quit playing and those at their desks kept getting up to watch. Some of the target students, however, did not appear to know their facts well enough to comfortably play the game.

Day 6a. . . .Ms. L.'s new group included Carrie*, Paul, Al*, Katie*, and Jackie*.

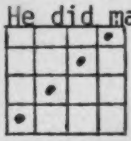
As the game began, Carrie* watched to see what Paul played and copied him. Jackie* looked at Katie's* board and copied her.



Al* was behind. He didn't comprehend the multiplication and answers quick enough to stay up with Ms. L.

One time, for the answer "4," he put down "2 x 4," having noticed the four.

He did manage to fill in four spaces diagonally.



But when having read the problem aloud, he said 2 times 4 equals 8, instead of 2 x 2 = 4, so the piece was removed and the game resumed. . .

11:08 Al* and Katie* were playing on their own and getting bingos. Carrie* and Jackie* were still looking at other boards for help.

Jackie* hadn't made a bingo yet. Even though Carrie* had, she didn't call one. . .

I asked Ms. L if students ever asked her to say "Bingo" as she played a board also. She said she played a board to keep track of answers.

Ms. L. said she realized Carrie* made bingos by looking at other students' boards, therefore she did not call attention to it. (G, 3/10, pp. 3-6)

Direct Services of the Mathematics Project Specialist

The day the MPS, Ms. W., came into the classroom, the teacher gave the students Test 9, Multiplication and Division Basic Facts, pages 130-166, Mathematics Around Us (see Appendix A, protocol 3/16). Katie*, who had performed well in previous activities, had drawn a graph strip on her desk. She spent most of the time looking around. (Two-thirds of the students failed the test).

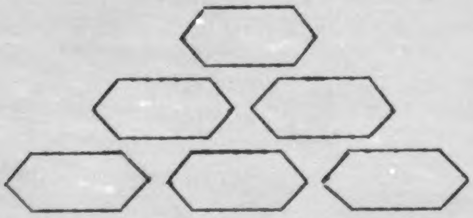
After the test was completed, Ms. W. called two groups of students, heterogeneously grouped, consecutively. Ms. W. went through a series of exercises using pattern blocks. The objective was to denote "whole" and the fractions one half, one third, one fourth and one sixth. After the exercises, the group played "Pattern Block Cover-Up." The protocol is found in Appendix A. Target students, including Katie*, performed the task as well as non-target students. The protocol indicates that the teacher observed the lesson while grading papers.

The next day, Ms. W. (MPS), again worked with the same two groups. First the children worked on worksheets used with pattern blocks to allow children to divide space with different shapes, and to learn the relative size of one colored pattern block to another. The children required a great deal of assistance in performing the task. Then the MPS showed how to play a game, "Block Exchange," which required students to trade smaller blocks that were equivalent to larger blocks.

Day 8. . . .Ms. W. passed out a laminated game board.
Ms. W. : Show me when you're ready to listen.
It was quieter.
Ms. W. : This die has 1, 2, 3, 4, 5 and 6 on it. If I roll a 2, I get 2 green triangles. Next I roll a 6. Now I have 8 green triangles. What can I exchange for?
Sts. : A blue. . .
Ms. W. : Ok, anything else?
Sts. : A red, two red
Katherine rolled a five.
Ms. W. : Five green. What can you exchange it for?
Katherine: A red.
Ms. W. : Another red? Put the green on top. What else would two green make?
Katherine: A blue.

The game proceeded. . .

Block Exchange



It's a long game, trying to cover six hexagons with six yellow hexagons, but the game always starts with green triangles and having to work your way up to hexagons. (G, 3/17, pp. 3-5)

Observations After the Mathematics Project Specialist Left the Classroom

The next week, Monday March 23, Ms. L., the aide, continued the fraction workshop with the same groups of students that the MPS had worked with. Students also continued to work on the 8's multiplication and division facts.

Ms. L. followed the same procedures used in the Title I math inservice in the fall. The protocol (G, 3/23) indicates a detailed and thorough lesson involving verbalization of fractions and paper strip representations of one whole, fourths, eights and sixteenths. Students made the fractional pieces necessary for playing the game Roll and Remove and had put their pieces into envelopes before lunch.

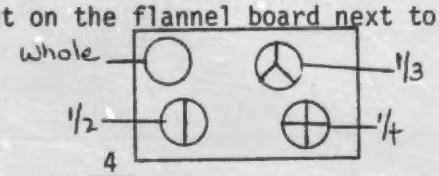
The next day (3/24) the classroom teacher worked on fractions, using a worksheet and flannel board, with the lower achievers, while the other students worked on language with the aide. The lesson required students to associate fractional parts with visual and symbolic representations. The terms numerator and denominator were not used.

Day 10. . . .10:30 Laura was asked to read the first problem.
Bill : It's zero!
Ms. R. wrote "$\frac{0}{2}$"
T : What's the fraction?
Bill : Zero.
T : Zero what?
Bill : Two's.
T : We call two's what?

St.* : Halves.
T : The fraction is zero halves.
Bill read the second problem.
T : What's at the top?
What would you color?
Bill : Four.

*Didn't catch who was speaking

T : And the bottom number?
How many parts are there?
K : Four.
Ms. R. wrote "$\frac{4}{4}$"
Ms. R. put on the flannel board next to her:



T : Bill, $\frac{4}{4}$'s is the same as?
Bill : A whole.
T : Could we write $\frac{4}{4} = 1$?
Bill : Yes. . .

Her new group included: Jake, Katie*, Jodi, Roger, and Maria.
T : Find a half to cover up this
*blue circle or whole.
Maria : One yellow.
She covered it up, and wrote $\boxed{\frac{1}{2}}$
on the lamenated board. (G, 3/24, p. 1-2, 4)

On the last observation day (3/30), students took a multiplication test from the math book. Ms. R. showed the ethnographic assistant the results of the fractions test, given at the end of last week, during another MPS visit, that was a repetition of a test failed by the students the first time. Twenty-five of the twenty-seven students passed this test. Only Carrie* and Jackie* had failed, the other 3 target students did well. After finishing the test, children worked at cutting squares into halves and pasting them on to cardboard.

Final Interview Following the Observation Period

The principal investigator and ethnographic assistant conducted an interview with the classroom teacher following the study on April 7. Ms. R. said that the selection of math topics was different every time the Mathematics Specialist was scheduled to work in the room. The first time the MPS had demonstrated teaching with Cuisenaire rods while the teacher watched (2 sessions) and later for the aide. Next the MPS had done a follow up activity to reinforce multiplication. This time the MPS had presented a whole new unit. The overlapping of topics, e.g. multiplication and fractions, was not unusual. The MPS usually works with all students but perhaps more with target students. She had worked in the classroom at least 15 days this year.

The workshops have helped the teacher more than anything else. She has built up her math curriculum from the inservices and being able to actually see how the material is presented to children is great. She has really changed her teaching style a lot. Having an aide or another adult in the classroom is very important. Ms. R. said it would be hard to do centers otherwise.

The teacher was disappointed that 10 students hadn't passed the second multiplication test. Only 3 more passed the second test than had passed the first test. She felt the textbook test didn't really evaluate her unit since it included items not covered in the unit such as number lines, word problems and money. Also the directions weren't clear. She planned to construct her own end-of-the-year test in mathematics. She was also concerned about the two target students who had failed the fractions test despite the extra help received. She wondered if perhaps they should be referred to the LD program.

Summary

The classroom teacher in research site G was a second-year participant in the Title I mathematics project. Observations of the ongoing classroom mathematics project occurred late in the year and indicated regular use of Cuisenaire rods and graph paper and other aids in instruction in a unit on multiplication and division. This instructional strategy was similar to that observed in Title I mathematics inservices. The Title I Mathematics Resource Teacher had also modeled using Cuisenaire rods in the classroom earlier in the year. Usually the teacher, and her highly skilled aide, worked as a team rotating subjects and small groups of students. The attention and involvement of children in instruction, using manipulative aids, appeared to be superior in small group instruction (facilitated by the aide's assistance) than in whole group instruction (without an aide's assistance).

Students were also observed playing a math game, called Bingo, which required students to know their multiplication facts in symbolic form. Students seemed highly interested in the game but target students had some difficulty playing it as they did not have complete control of the facts. In the final interview the teacher stated she had built her math curriculum through the math inservices.

The mathematics project specialist (MPS) provided 3 days of direct services to two small groups of target and nontarget low achievers in a unit on fractions. Fourteen teaching sessions were provided throughout the year. Her instruction included pattern block activities and a game, Patter Block Cover Up. Target and nontarget students were equally successful on the tasks. The classroom aide, had also received training from Title I math, continued the manipulative approach, derived from previous Title I inservices to fractions with the same small groups after the MPS left the room.

The teacher evaluated the achievement of students through tests, which indicated that 3 of the 5 target students had passed the fraction test. She was concerned about the failure of the other two children and considered referring them to the Learning Disabilities program. She was disappointed that 10 of the 27 children had failed the second multiplication test but thought this might be due to a mis-match between her curriculum and certain test items and terms on the textbook quiz.

Study G

Observation Schedule

Date	Day	Hours	Minutes
2/25/81	Wed.	1	10
2/26/81	Thurs.	1	15
3/3/81	Tues.	1	15
3/9/81	Mon.	1	15
3/10/81	Tues.	1	
3/16/81	Mon.	1	30
3/17/81	Tues.	1	
3/23/81	Mon.	1	20
3/24/81	Tues.	1	10
3/30/81	Mon.	1	

TOTAL - Days: 10 Hours: 11 Minutes: 55

Classroom Ethnography Case Study
for Research Site H
Third Grade

Context of the Research Setting

At mid-January when the research study was scheduled to begin, Teacher H had organized her hour-long mathematics instructional period into four rotating groups. Monday through Thursday there were two instructional groups as the Title I project assistant, based at the school, taught two of the instructional groups while the classroom teacher taught the other two. The teacher and project assistant were both bilingual and Mexican American as were the majority of the children in the classroom. This is the first time we were to observe a Title I project assistant giving direct instruction in mathematics to children, but this was unusual only in regularity and integration of this Title I program implementation strategy in the classroom. (Title I project assistants were highly-qualified teachers who worked with teachers and Title I aides to improve the curriculum of participating students at all grade levels in Title I project schools. For a description of their job role, see Slaughter, 1978-79.)

The two "followup" groups were supervised by a Title I instructional aide and a classroom volunteer. The volunteer aide had become involved in classroom volunteer work when a younger sibling was in first grade (with the same teacher) and worked as a followup to the teacher's instructional group.

Teacher H stated that she and the Title I project assistant both do the same thing during instruction but use different media. The project assistant used cuisenaire rods for instruction and was considered a specialist in this by the classroom teacher. For one thing, the project assistant had presented workshops to District teachers about using cuisenaire rods when they had been adopted as a regular part of the instructional materials three years previously.

The teacher's perception of the Title I Math Project during the initial interview was that the three math project specialists (MPS) mainly provided ideas and materials. The teacher had received materials from Joanne, the MPS, from the math workshop missed on January 20, 1981. (Mrs. H missed the math workshop because she had been asked by the District to attend another workshop to learn how to administer a newly developed Language Proficiency Measure for bilingual students.) Mrs. H said that Joanne (the Title I MPS) had come to her classroom a few times in the beginning of the year and would probably come a few times in the spring, but that the MPS involvement in the classroom was minimal. She concurred with the principal investigator's (PI) suggestion that since the Title I project assistant (PA) worked in the classroom regularly, the role of the MPS in her case would be different from a classroom where there was not this type of direct service from a Title I PA. Mrs. H also mentioned that Joanne did not give her much notice before she came. There had been an after-school conference arranged between the teacher and MPS the previous week but it was canceled because the MPS said something had come up.

The role of the Title I project assistant in this classroom was unique. The teacher had derived her rotating math schedule from a Title I mathematics workshop presented in the previous spring by a university mathematics educator. However, she did not attempt to put her grouping plan into action until after the Title I PA, who was new in the building that year, volunteered to help in her classroom in the fall. Then, with an adult to supervise each of the four groups, the plan was implemented. Heterogeneous groups were formed as the teacher felt all the children were equally unknowledgeable about fractions. The teacher felt there was no stigma attached to groupings because of their heterogeneous and changing character. At the time that the research study began, the teacher had formed new groups based on mathematical performance for a unit on multiplication.

Organization of this Report

This report describes periodic observations over a five-week time span of a classroom mathematics program. Major points are illustrated by excerpts from protocols written for each observation day. These are indexed by study identifier, letter, date of observation and protocol page number. All names are fictitious and do not reflect ethnicity. The names of Title I project participants are marked with an asterisk.

Pertinent names are:

Mrs. Brown:	Classroom Teacher
Mrs. Gray:	Title I Project Assistant for the school
Mrs. See:	Title I Mathematics Project Specialist (MPS) providing classroom services
Mrs. Jones:	MPS
Mrs. Wing:	MPS
Mrs. Johns:	Title I Classroom Aide
Miss White:	Volunteer Aide

Tim, Karen, Vickie, Don, David, Ted, Scott, Boyd, Gary and Ben were target students.

First Observations

The protocol from the first observation described the grouping plan used for mathematics instruction and provided a detailed account of both the classroom teacher and the Title I project assistant teaching the zero and one multiplication facts.

Day 1a. . . .At 12:30, the students were called to their places on the braided rug located on the middle of the floor. Here the students sat facing the side blackboard as the teacher was sitting on a table talking to the students. Mrs. Brown told the students where the various groups were going to be working. Icicles were to go with Mrs. Brown to the instruction table. The Snowmen were to go to Miss White for followup. The Snowflakes were to report to Mrs. Gray (PA) for instruction and the Snowballs were to report to Mrs. Johns. . . (H, 1/28, p. 1)

Mrs. Brown, the classroom teacher, used materials sent to her by Mrs. See (MPS) for the lesson. Throughout the observation period, the protocol data indicates use of materials and games from the Title I project. (See Appendix for workshop description.) Manipulative aids were used in conjunction with written symbols on the board.

Day 1b. . . .Mrs. Brown asked each child to take a portion cup which each did quietly. "There is nothing in here. How can I write that?" Ann answered, "0 x 1 = 1." Mrs. Brown explained: "How many tiles in my portion cup?" The five students together answered, "zero." The group answered softly, "one." On the board she wrote 0 1 = . "How many tiles?" No children answered. "How many cups? One, so. . .0 x 1 = 0." Mrs. Brown asked them to write the fact in the first top square. "This time take another portion cup and no tiles." Rick went to the board and wrote 0 x 2 = 0. The students wrote 0 x 2 = 0 in the next box on their paper. . . (H, 1/28, p. 2)

Mrs. Gray, the Title I project assistant, was teaching a group of monolingual and predominant Spanish speakers, bilingually.

Day 1c. . . .Mrs. Gray was giving directions in Spanish. She told me she was working on zero, ones and twos. She asked everyone in her group to take two portion cups. Mrs. Gray (PA) gave each student a handful of small cubes called Whites. As Mrs. Gray continued in Spanish, I watched by sitting at the head of the two tables together facing Mrs. Gray and the back door. Each student has two

> cups and one White in each cup. "How many do we have altogether?" asked Mrs. Gray in English. The group answered altogether, "two." In Spanish and English, "Put zero Whites in each cup. Zero means nothing or is invisible." In Spanish I guessed she said to put three Whites in each cup, making a total of six. Each child put three Whites in each cup; each child had two cups. In English she said, "Add one more and see what you have." 4 x 2 = 8. "Add another White in each cup. Now what do you notice?" Mrs. Gray answered, "I am multiplying in order, 2 x 1 = 2, and you are counting by two's. You are doubling or adding two more each time." The group went on to do 2 x 6 in portion cups, making 12. . . (H, 1/28, pp. 2-3)

After class, the ethnographic assistant talked with Mrs. Gray about her involvement in the classroom math program.

Day 1d. . . .She and Mrs. Brown started this program in October and enjoy it. She can see progress. She can especially see progress with the five monolingual students and was proud of them. Mrs. Gray said they had been working about two weeks with lots of manipulatives getting the students ready for computation. Now she felt they were ready to handle multiplication facts.

> Mrs. Gray had given math workshops at Lincoln School last year and really enjoyed it. She explained that once you have an idea it is very easy to build the concept around manipulatives. . . (H, 1/28, pp. 8-9)

Classroom H was typified by a highly structured classroom organization and grouping procedure. The ethnographic assistant noticed:

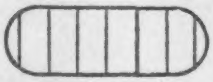
> . . .This class is so orderly and quiet! The teacher rules and the students respond to her. There is laughter and fun but yet everything has a place and should be always put back in that place. Example: The glue belongs under the sink in the cupboard and that is where

> it should be found at all times when not in use.
>
> Everyone has his name on his or her chair with masking tape. The individual has the responsibility of that chair. The pencils were placed in juice cans at their tables. The cans were covered with contact paper. . . (Excerpt "a", p. 1, comments)

Mrs. Brown enlisted student help in getting ready for math, and while waiting for the aide and Mrs. Gray to arrive rearranged the seating order on the rug. This description is included as it suggests the kinds of conceptual patterns exemplified by the math program. The protocol begins with the addition of new names to the Title I target list.

Day 2a. . . .12:39. Mrs. Brown asked me to please add *David, *Gary and *Ben to her target list. 12:40. Mrs. Brown asked the class to get ready for math. Getting Ready: Students moved tables together to make a larger work area. Students erased the front blackboard by the instructional table. Students moved chairs to proper groups and handed in all finished work to the back table. 12:44. Mrs. Brown asked the students to be seated on the braided rug as she had decided it was time to move the class around. "I think it is time to change the seating on the rug," said Mrs. Brown. "No," answered the students. The students' answer was ignored. Teacher: "Who would like to sit in front that hasn't?" Many students answered. However, all the boys were removed from the rug first and asked to stand on the tile. Teacher: "We are going in alphabetical order. Think of your first name and the letter it begins with." There was a pause before the girls were asked to remove their bodies from the rug and to stand on the tile.

There were seven masking-taped lines on the rug for the students to sit on Indian-style and hands folded in their laps.

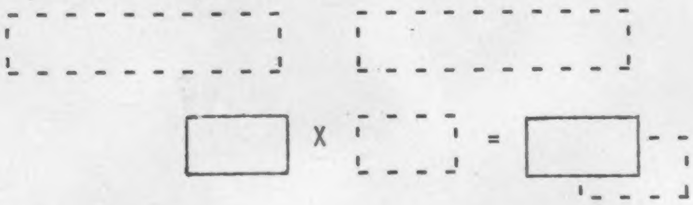


Many students were relocated on the rug where they were reminded that if they talk then they couldn't sit together. The

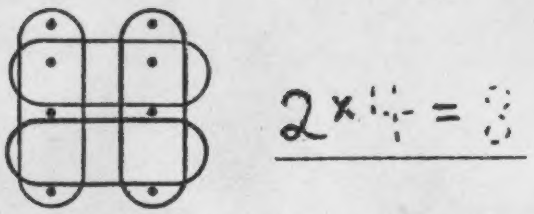
> students sat quietly and were orderly.
>
> At 12:50, everyone was here and ready for math. Mrs. Brown asked Snowballs to meet with Miss White for followup, Snowflakes to Mrs. Brown for instruction, Icicles to Mrs. Gray for instruction and Snowmen went to Mrs. Johns for followup. . . (H, 1/29, pp. 2-3)

The followup activities closely supervised by the volunteer, Miss White, and the aide, Mrs. Johns, provided visual models as well as symbolic representations of the multiplication facts. Mrs. Johns taught bilingually and was using materials from the workshop.

Day 2b. . . .In Miss White's group the Snowballs were working on a worksheet. The students made up their own facts and glued small orange squares to represent the fact. For example:



> The glue was shared by every two students. Three boys had difficulty opening their glue as the glue had caked over the opening. Miss White walked around the table and saw that each person was doing his work correctly. Every student was interested in what s/he was doing. Very little talking was taking place.
>
> At 1:03 I left Miss White's for Mrs. Johns' group. The students were answering the ones and zeros on their facts sheet given out at the math workshop. After the answers were completed for zeros they were colored yellow and ones were colored lime. There were seven students in this group, which meant everyone was here.
>
> In Spanish an explanation of the next worksheet was given by Mrs. Johns. There were ten items on the worksheet. It looked like this:

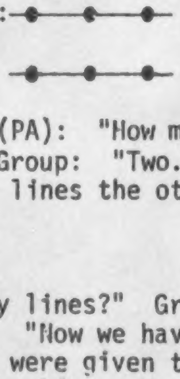


> The students were to fill in the dotted answers. . . (H, 1/29, pp. 3-4)

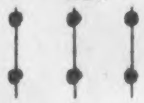
Mrs. Gray, the project assistant (PA) was observed instructing first the Icicle group and later the Snowball group; two different activities were used for the two groups representing a greater investment in planning time for the PA than one activity would have required. The first activity used grids to explain multiplication groupings:

Day 2c. . . .At 1:08 I left to observe the Icicle group. They were starting grids with Mrs. Gray (PA) instructing. Example:

> o o o
> 2 x =
> o o o
>
> The students were told they were going to connect dots and would always start this way:



> Teacher (PA): "How many lines did we draw?" Group: "Two." Teacher: "Now draw the lines the other way:"



> "How many lines?" Group: "Three." Teacher: "Now we have 2 x 3 = 6." The students were given their worksheets and started working. Most students used more than one color to complete their grids. *Tim used green (←——) and blue (↓) and facts were done in pencil. Ann was having difficulty so Mrs. Gray (PA) helped her by explaining in terms of jacks. I looked back on *Tim and found he had made a □ around the dots. . . (H, 1/29, pp. 4-5)

Mrs. Gray used portion cups and white tiles to illustrate multiplication for the Snowball group. Mrs. Gray also recorded the equations for the children to see.

On the third observation day, Monday, math games from the Title I workshop and also teacher-originated games were used for instruction at all four centers. The volunteer aide was absent, so the Backwards Bingo game did not have an adult "leader." Mrs. Brown taught Obey The Signs, a game that took about ten minutes to complete and which was popular with the students. Mrs. Gray taught the Grudge Game, a game that was the longest of the four and would take longer to complete than the half period time allotted to one group activity. Mrs. Johns' group played Tiles and Flags, a game designed to be played quietly in the classroom as children held up tiny flags rather than shouting out to indicate they had the answer.

The Grudge Game was played with children sitting around a single table so all could reach the pipe cleaner "Grudge." The logistics of passing cards in a specific direction as well as holding the cards had to be learned as well as math concepts.

Day 3a. . . .Mrs. Gray (PA) passed out the grudge cards and had the students lay their cards down on the table to make a family. I was sitting in the desk aside of the back table and back door. The PA walked around the table and checked each student's cards for pairs and families. She then asked each person to pick up their cards and hold them like a regular deck of cards. Mrs. Gray asked the group to pick a card they didn't want and place if face down on the table. Then she told them to pass it to their left. *Don was the only one to pass his card to the right. At 1:07 they were asked to do this again and passed. Ken wanted to know if he could put part of his family down on the table. Mrs. Gray said, "no, as the group will not pass the right card to you." At 1:11 Ken had dropped his cards and didn't pass a card. Mrs. Gray asked, "what happened?" Ken had a family of twos and was trying to put it down on the table when all of his cards fell out of his hands. In spite of this, he was able to grab a grudge while everyone laughed. He had 2 x 1, 1 x 2, and 2. In the laughter, the rest of the group forgot to grab a grudge. Mrs Gray (PA) said, "didn't you notice something?" Then it was a mad dash to grab a

> grudge except for Beth and Diane who did not understand the directions. Rose yelled, "grab one, Beth! Grab one, Beth!" Beth grabbed the grudge ahead of Diane although they reached at the same time. . . (H, 2/2, p. 3-4)

The Backwards Bingo game did not go as smoothly as there were some missing fact cards, which were quickly made by the ethnographic assistant who was sitting with the group (due to the absence of the volunteer). The point of the game was to uncover bingo cards by matching facts and answers. The aide, Mrs. Johns, was using a game technique with flash cards to check basic facts. Mrs. Brown helped students play a board game requiring students to state basic facts.

Day 3b. . . .Mrs. Brown sat at the head of the instruction table in front of her desk and played Obey the Signs. She had made the game on butcher paper and modified the facts for this lesson. The students rolled the dice to see who received the highest roll to go first. A fact was chosen from the fact box (zeros, ones and twos) and then read by the student aloud along with his answer. If the correct answer was given, the student rolled the dice to see how many spaces his pond should be moved. Certain squares asked you to move ahead or backwards or to move to certain places. . . (H, 2/2, p. 7)

After the observation, the project assistant, Mrs. Gray, told the ethnographer that she would soon be phasing herself out of Classroom H so that she could find time to work in other classrooms. She had not broached this subject with the classroom teacher but felt that perhaps parent volunteers could take her place in the grouping situation. Mrs. Gray thought that she might help out one day a week or one week a month to help Mrs. Brown carry the program through.

The next day, Tuesday, Miss White had returned and students were grouped for mathematics as usual. During the last part of the period, Mrs. Brown was called from the room and left the game in charge of a female student, who filled the role very well and was accepted by her peers. In directing the playing of the game for a Spanish monolingual child, Vickie, the child always waited until the teacher had always switched to Spanish to explain the play. The child group leader also did this code switching as did the other children in the group. All discourse was in English except when directed towards Vickie. Earlier the aide had been instructing Vickie in Spanish. Interestingly, when Rose, a student in the PA's group misbehaved, it was the teacher, Mrs. Brown, who disciplined the child.

Day 4a. . . .Rose, seated at Mrs. Gray's (PA) group, stood up and threw something across the room. Mrs. Brown called from across the room, "who threw that? We don't throw things in the room, Maria. . . (H, 2/3, p. 2-3)

The Snowball group, the group having the largest number of Title I target students (7), required a lot of teacher guidance from the PA in learning to play Grudge.

Day 4b. . . .At 1:13 I joined Mrs. Gray's group. *Scott was making a grudge (pipe cleaner) into a snake while Mrs. Gray (PA) explained the rules of Grudge. The pipe cleaner grudges were different colors--yellow, green, blue, orange and black.

*Boyd said he had a family when he didn't. When Mrs. Gray checked his cards she said, "there was a little bit of a mistake." The group was having a problem listening as they were distracted by the grudges. The group was having fun making all sorts of shapes. However, Mrs. Gray placed all the grudges in the middle of the table and asked everyone to choose a card not wanted and pass that card. Everyone was now back into the game. At 1:21 everyone was asked to count their cards as Mrs. Gray was not sure everyone was passing an unwanted card. She was right and collected all the cards and reshuffled. The group was disappointed as many were close to making families. *Boyd made the comment, "when are we finishing?" as the cards were passed out once again.

Later the group was back to playing the game of Grudge. Greg made the comment, "this is confusing." The group, including Greg, continued to play.

At 1:23 two buzzers were heard in the room, but no response was made. The Snowballs laid their cards down again to see if a family could be had. No one had a family at this point. At 1:25 they were asked to place cards in their hands. Once again

> directions were given about taking a card that the player didn't want and placing it in front of them so they were ready for passing. This time everyone passed and several rounds were played. . . .
>
> . . .Greg found it difficult to find families. His idea of family was 1 x 2, 2 x 1, but had trouble understanding an answer was needed to complete his family.
>
> *Boyd had a family and quietly took a grudge from the middle of the table. Everyone in the Snowball group managed to grab a grudge except *David. *David placed his G down in front of him on the table. . . .
>
> . . .Mrs. Gray (PA) had a small discussion concerning *Bonnie and the boys in the Snowball group. The boys had pinched, poked and called her names as the hot car was taken away. Mrs. Gray asked the group to act better by having made a deal where *Bonnie wouldn't pick on the boys and the boys wouldn't bother *Bonnie. . . .
>
> . . .*Scott had two possible families developing from the cards passed out. He was trying not to show his excitement. . . (H, 2/3, pp. 3-7)

The Backwards Bingo game was still missing some of the fact cards. Finally, Miss White simplified the game by having children put facts over the answers on the cards rather than removing them.

On Wednesday there was another observation of Vickie receiving needed explanation in Spanish, this time from Miss White, the volunteer aide.

Day 5a. . . .At the Bingo table as they cleared their board and had to recover the answers, *Vickie was having trouble covering her board. Miss White had to explain in Spanish the facts and what made the answers. After a few she understood the process and only had to have the facts said in Spanish and finally nothing was told to her. . . (H, 2/4, p. 2)

Also on Wednesday, Bonnie, a target student, was moved from an all-male group to the Snowball group, a mixed-sex group, in an attempt to improve her behavior. This change was later seen as successful.

On Thursday, two groups worked at the activities semi-independently receiving directions from the teacher (the PA was not present) while the other two groups were supervised by the aide and volunteer.

New games were again presented on Monday, a day on which it rained so hard that one could hardly hear. The games were War, for which students made flash cards to take home for studying, and Shake-a-Score, a dice game using paper and pencil also.

Mrs. Brown explained that each person had to say his card or give a mathematical sentence, e.g., $\begin{array}{r}0\\ \underline{\times\ 2}\end{array}$ two times zero equals zero, in playing War (the highest answer wins). The Shake-a-Score game required a written answer. Both games appeared easy to play and enjoyable to the students. Instructions to games were given in Spanish and English and children were observed talking in Spanish and laughing when playing the games.

Day 7a. . . .Sitting near the front door, I watched Shake-a-Score. All students had a paper with space for writing in the number rolled x 2 = and the answer. The students' sheet had eight spaces.

Name ____________________

5 x 2 = 10

7 x 2 = 14

x 2 =

x 2 =

x 2 =

Score __________

The dice were rolled and the number shown was the number written on the paper. It was multiplied by 2 and an answer was written. At the end of eight rolls, the answers were added together for a score. The person with the highest score was the winner and received a big heart sticker on his paper by Mrs. Brown. The group was reminded over and over again by Mrs. Brown to not help each other and not to say the answer out loud. Rose and Ann were missing from this group. *Tim rolled a double 6 and was surprised. He was able to get 24 for his answer by counting by twos. . . .

. . .At Shake-a-Score, Ron won with a score of 272. Mrs. Brown added everyone's score and was surprised at his high score. A big heart sticker was placed on his paper while small heart stickers were placed on the others.

At 1:15 the groups rotated quickly and quietly.

Ed was excited as he left Shake-a-Score saying, "oh boy! Now I can play this at home now."

The Snowflakes had to wait a couple of minutes for the Snowball group to finish writing facts. The Snowflake group stood waiting patiently by the table of the Snowball group. . . (H, 2/9, pp. 6-8)

Classroom Services of the Mathematics Project Specialist

The Mathematics Project Specialist (MPS), Mrs. See, instructed two groups of students following the same rotational pattern as seen in previous mathematics periods. As the teacher was also conducting a group lesson, there was no opportunity for her to observe the MPS. Mrs. See worked at a table nearest the back door where Mrs. Gray, the PA, had previously worked. The following excerpt from the protocol shows Mrs. See teaching multiplication concepts with geometric shapes to the group containing the largest number of target students.

Day 8a. . . .When I arrived at 12:32, Mrs. See (MPS) and Mrs. Stone (PI) were enjoying Roger's guitar birthday cake. I also enjoyed a piece of cake. The students were enjoying theirs on the braided rug.

At 12:40 the students were dismissed from the rug to their math groups.

Noticed that today *Ted was moved from Snowball group to the Snowman group.

In the Snowball group with Mrs. See (MPS) the students were asked to take one hexagon-shaped piece and two triangles from the middle of the table. With these pieces Mrs. See showed the group how a fish was made. Each student was asked to copy her design. Then asked to make another fish like their other one.

MPS: "What do you think I am going to make next?"

Group softly: "Fish."

MPS: "Make it."

Greg: "How many fish do we have?"

MPS: "You read my mind, Greg! What am I going to ask?"

Greg: "How many fish?"

Group: "Four."

MPS: "Right! Now one more fish for our school. How many fish?"

Group: "Five."

MPS: "How many fins?"

Group: "Ten."

MPS: "I am going to give you paper and I want you to write your name at the top. This is to keep a record."

12:45 a buzzer rang and the students told the MPS that it was a bell for the other students.

Roger saw a pattern at this point and let Mrs. See know. "One fish, two fins; two fishes, four fins; three fishes, six fins," etc. The MPS complimented Roger on his knowledge and he was PROUD.

Mrs. See (MPS) asked the group to make their sixth fish and was asked to count the fins. The fins were counted by twos.

MPS: "If we had another fish, how many fins?"

No answer was given.

MPS: "Hands in lap."

The group waited for *Boyd and Greg to follow directions.

In reference to the report each student was using, Mrs. See asked:

MPS: "Do you see a pattern there?"

Roger: "Yes. We are counting two, four, six," etc.

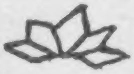
MPS: "Very good! We are going to try a harder one."

First the MPS had *Boyd put his fins away quietly. Everyone listened except Greg as he was putting his fish away at the same time as *Boyd.

MPS: "Gracias, Greg."

The group chuckled! Greg was talking to *David when Mrs. See stated that the group was going to make another figure.

MPS: "See if you can guess what I am making?" as she made this figure.

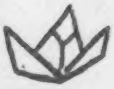


MPS: "I will give you a hint. It is a living thing."

Group: "Flower."

MPS: "Right, but I didn't make it right."

She looked in her folder and saw how the flower should have been made. Mrs. See remade her flower.



The group told her it was a tulip before she finished.

MPS: "You guys are too fast! You will need four tan and one blue to make your tulips."

(The pattern of speech was: "Looking at your tulips, how many do you have?" The students always answered correctly.)

When three tulips had been made, the MPS asked, "how many tulips?"

Students: "Three."

MPS: "How many blocks?"

Students" "15."

MPS: "You guys are too smart!"

Before the MPS could finish her sentence, *Boyd reached for the proper number of blocks and made another tulip.

The students were to write their reports which each did, but *Boyd finished first. However, Greg needed help which was given him. The rest of the group made a rocket while the MPS helped Greg. In trying to get Greg to see the pattern, Mrs. See (MPS) had Greg pile his blocks rather than to build a tulip.

MPS: "How many blocks do we need to build a tulip?"

Greg: "Five."

Then the MPS asked Greg to count her fingers for 8 x 5, which Greg gave 40 as his answer.

MPS: "Now I have nine tulips. How many blocks?"

Greg: "45."

> Greg was able to do 10 x 5 on his own using his fingers. When he finished Mrs. See asked Greg to make something with his blocks. To Greg she said, "what good work you did!" She patted his right shoulder. Greg had made a flower.
>
> Gary had made a big circle of flowers (tulips).
>
> MPS to group: "As nicely as you can, put the shapes back in the box."
>
> At 1:03 Mrs. See asked Mrs. Brown, with the group behind MPS, what time to change. "A couple of minutes," answered Mrs. Brown. Mrs. See closed her eyes as the group put their blocks away. She opened her eyes at 1:05 and found all the blocks had been put away. The group was excused for a drink before changing to the next group. . . . (H, 2/10, pp. 1-6)

The second day the MPS was in the room was the day before the Valentine's Day party and the students presented her and the ethnographic assistant with child-made valentine corsages. The MPS had offered to help with the next day's valentine party at which the children were going to apply their math by making refreshments.

The room was organized as usual in four groups. The MPS taught the two groups she had not worked with the previous day to play Old Strawberry, a game modeled on Old Maid, requiring students to match multiplication facts and answers. Mrs. Brown had the students play "math" concentration, a game requiring the same skill. The aide was using rods to build clocks to be used to teach multiplication skills and Miss White was teaching the students to play Five Up, another multiplication game.

Before the Old Strawberry game, Mrs. See used pattern blocks to help students visualize the concept of multiplying.

Day 9a. . . .At 12:50 Mrs. See (MPS) was working in Spanish and creating a flower. She must have asked the group in Spanish what they thought she was making because in English they were saying, "body," "bug," "plant," and finally "flower." The whole group then made a tulip. *Ted was in this group again today so I guess he was switched from the Snowball group to the Snowman group.

MPS: "What do you think the pattern is?"

*Ted: "Five."

On the record sheet a pattern was developing:
1 x 5 5
2 x 5 10

this was repeated through 10 x 5. Everyone in the group was able to do the record sheet.

MPS: "Put your finger on Number 6. What do you have to do with 6 flowers? How many 5s would I need to make 30?"

Group: "6.". . . (H, 2/12, pp. 3-4)

The aide used the clock idea to help students to see relationships between counting by fives and the five's multiplication facts.

Day 9b. . . .Aide: "Do we have a 12?"

Group: "No."

Aide: "Do we have a rod half of 12?"

Group: "Yes, 6."

Two 6s make 12 or two dark greens.

*Don had two greens to the left of the middle and was corrected by the aide.

Aide: "Look at the clock and see where the 12 is. What is at the bottom of the clock?"

Group: "6."

Aide: "Need one green at the bottom. What number is to the right of the clock? Why did we use yellow for the clock?"

Brian: "Because the clock is counting by 5s."

Aide: "Right, we count by 5s to tell time

> on the clock. What is the next number?"
>
> Group: "4. Maroon."
>
> Aide: "Which is 5?"
>
> Brian: "Yellow."
>
> At 1:02 clapping was heard from Mrs. Brown's area. She explained to the whole class proudly that *David had finally gotten a pair.
>
> As the clock got higher in numbers, *Don had trouble placing rods in proper place and order. The aide had the group count by 5s on their clocks by asking how many yellows to reach 10. The group responded with 50. . . .
>
> . . .I then at 1:19 observed the aide again with another group to capture some of the clock building.
>
> Aide: "5 x 3"
>
> Group: "15"
>
> Aide: "5 x 5"
>
> Group: "10," then quickly corrected themselves, "25."
>
> This was continued until 5 x 11 was reached and Roger answered, "55."
>
> Aide: "We are going to make a clock using cuisenaire rods." Holding up a yellow rod, "what number is this?" Five. Remember when the rods had numbers. Get 12 yellows and make a clock or a circle. If they kinda touch you can make a circle.". . .
> (H, 2/12, pp. 5-7)

In teaching the game Old Strawberry, the MPS also taught students the social skill of keeping a "poker" face.

Day 9c. . . .It was obvious to me that Linda had "Old Strawberry" as she curved her cards for Ruth. Ruth did not choose "Old Strawberry."

When Mrs. See (MPS) realized she had gone the way for the third round had Ruth return the card while Rose chose from Rick.

MPS: "Suppose I saw "Old Strawberry" in my hand, what should you do?"

Ron: "Pretend you didn't see it."

MPS: "That's right."

The MPS stopped a few minutes thereafter and explained they had to stop for today but could continue the game another time. The MPS took cards from Linda and demonstrated how the "Old Strawberry" was to have kept moving so no one knew you had it. Then she held the "Old Strawberry" card slightly above the others and asked the group if they would choose the "Old Strawberry." The group answered, "no." The MPS complimented Linda on the good job of hiding "Old Strawberry" throughout the game. . . (H, 2/12, pp. 9-10)

Postintervention Phase: The Classroom Mathematics Program After Resource Teacher Services Were Completed

This section of the case study describes the situation in the classroom during the next two weeks after the scheduled visits of the Mathematics Project Specialist (MPS) were over and after the Title I project assistant was no longer in the room. There were, however, two brief visits from another MPS, Mrs. M, who came to the room for the purpose of taking pictures of the children working on activities. Because she was in the classroom, Mrs. M got involved in helping the aides with their group activities. For instance, on Monday Mrs. M explained how to play the game, Create a Monster, a game she had invented (for practicing the zero, two, one and five facts) to Miss White's group while Miss White prepared some materials. The other group played a different game, Knock Your Block Off, that also required knowledge of these facts.

On Monday, Mrs. Brown tested groups of students on 35 multiplication facts using a technique she had learned from Mrs. See

(MPS). Another group worked on coloring facts, making flash cards and working in the math textbook. This was the first time textbook use had been observed as the teacher had made a concentrated attempt to develop concepts first through manipulative aids. As an introduction to the day's activities, Mrs. Brown had reviewed the five's facts and the math language with the whole group.

Day 10. . . .While the class, seated on the rug, was counting by fives, Mrs. Brown was writing (side blackboard):

xxxxx 5 x 1 = 5

xxxxx
xxxxx 5 x 2 = 10

xxxxx
xxxxx 5 x 3 = 15
xxxxx

Teacher: "What are we doing?"

Pupils: "Counting by fives."

Teacher: "Yes. Is there another name?"

Pupils: "Adding five each time."

Teacher: "Yes, what is this called?" (pointing to the board).

Pupils: "Multiplying by five."

Teacher: "Excellent!". . . (H, 2/16, pp. 1-2)

The next day, Tuesday, the same activities (which were going smoothly) were continued with the addition of a more formal paper and pencil task--a task that some of the target students found difficult.

Day 11. . . .*Ben found the math pages "hard." The pages consisted of pictures where students made equations to fit the pictures. Other pages had equations like 1 x 1 = ____,
____ x 5 = 15, ____ x ____ = ____.
*Gary was having the same problem trying to make the equation fit the pictures. However, the group found a column of facts "easy."

*Ben accused *Gary of copying, which he was, and Gary didn't deny him. *Ben understood facts as facts.

> *Boyd asked me what was this:
>
> The product is ______. There are
> ______ flowers.
>
> I explained to him that product was another word for answer. He was able to continue his work. . . .
>
> . . .*Bonnie was having trouble knowing whether the bees or flowers were first in her picture in the math book. __ x 2 = 10 There were two flowers and five bees in each flower pictured in the book. . . (H, 2/17, pp. 4, 7-8)

On the following Monday, Mrs. Brown continued to evaluate the students' knowledge of multiplication facts in order to regroup students for continuing the unit. The other groups played Five Up (game), Concentration (game) and also used graph paper to make arrays illustrating the five's facts through 5 x 6. The aide, Mrs. Johns, asked the MPS, Mrs. M., who was in the room to take pictures, for some information about Five Up.

Day 12a. . . .The Five Up table. The cards had colored zeros and Mrs. Wing (MPS), when asked how to use the zeros, replied that usually the deck did not consist of zeros. The aide removed the zeros and asked the MPS how to start the game. She told them that the game was started with a red 5. The red 5 started the game and the person to the right or left could move and build or start a new 5 or pass. . . (H, 2/23, pp. 2-3)

The children appeared to be involved in the game activities and still in need of more practice.

Day 12b. . . .At the concentration game at 1:00, to see *Ben had turned over a 14. I asked him what he needed to make a match.

> *Ben: "7 and a 2."
>
> Roger: "1 x 14."
>
> However *Ben drew a 3. *Boyd and *David were still without a pair. It was time to change at 1:03 and *Boyd expressed disappointment as he said, "see I lost." When the cards were being cleared from

the table, *Boyd was excited, having found two pairs. 1:05. The boys left the cards on the table for Ken, Judy, Beth, Diane and Brian. Judy drew 7 x 0 and a 0 and asked me, "lady?" showing me the cards.

Beth: "Is that a pair?" (pointing to Judy's cards).

EA: "Yes or maybe it isn't. How much is 7 x 0."

Judy: "Zero."

EA: "Is that what you have?"

Judy: "Yes!" as she put the two cards together. . . (H, 2/23, pp. 4-5)

The next day the same activities were observed. The ethnographic assistant observed that Brian (not a target student) still acted like he didn't like math, but that he responded well to individual attention from the volunteer aid.

Day 13a. . . .At the array table, Brian had told Miss White that he doesn't get it.

Helper: "What don't you get? It is simple. Look, count five cubes. Then color in five squares.

Now Brian was doing it and had $\begin{array}{r} 5 \\ \times\ 1 \\ \hline 5 \end{array}$

for his equation, while others had 5 x 1 = 5. . . (H, 2/24, p. 3)

There were also other examples that the children were learning through the manipulative aids.

Day 13b. . . .The Snowball group thought the array center was easy. Roger and *Gary finished first. Their work was checked by Miss White before putting it into their cubby.

Roger wanted me to see how quickly he could count by fives. He brought four

> rows of orange interlocking cubes to me saying, "5 x 4 is 20." Then showing me one row at a time but quickly 5, 10, 15, 20. . . (H, 2/24, p. 2)

During the last observation, a total group game, similar to musical chairs, was played using math flash cards. This lesson was somewhat informal as the teacher had been out the day before and also the ethnographic assistant had brought the class a treat, doughnuts, as it was her last day in the classroom. During the end of the period, students were observed quietly playing math games as a free activity.

Final Interview Following The Observation Period

Mrs. Brown was very positive about the assistance provided to her classroom mathematics program through the Title I mathematics resources program and project assistant help. Mrs. Brown felt that both a demonstration-modeling function and a team-teaching function applied to her collaboration with the program. She stated that the MPS, Mrs. See, had demonstrated how to teach multiplication. This had been useful because since she had taught first grade before this year, she had been inexperienced in teaching multiplication. The modeling had occurred after school and during the half-day individual inservice in the Title I mathematics room. Mrs. Brown had team taught with Mrs. Gray, the Title I project assistant and has continued to plan/brainstorm about the math program after school with her even now when Mrs. Gray is working in three other classrooms to implement the program.

Mrs. Brown felt that she couldn't work with resource teachers before this year because they had not been available on a regular daily basis.

The teacher liked the four-days-a-week observation schedule. That way the observer is there long enough for the teacher to work the kinks out of the program.

Mrs. Brown indicated that her evaluation of student learning showed that the children were mastering the concepts taught through maipulatives. In the fall, the pre- and posttest provided by a math consultant indicated that students showed good gains. The evaluation of the unit on multiplication, via flash cards used on an individual basis, demonstrated that children had learned their facts.

Summary

This classroom presented an atypical and unique context for viewing implementation in that the teacher had the assistance of three additional adults, project assistant, aide and regular volunteer, in implementing the mathematics program. Indeed, Teacher H stated that a major reason she had decided to implement the program was that Mrs. Gray, a highly skilled project specialist at the school, had agreed to teach two groups of low achieving students, four days a week. This had permitted a symmetrical grouping arrangement, with an adult to direct and guide each separate group. Children therefore experienced two adult assisted activities daily and received a great deal of individual assistance. Therefore in the context games were used as an instructional medium as well as to reinforce or maintain skills.

A team teaching model describes the relationship between teacher and project assistant. The entry of the Title I Mathematics Specialist (MPS) into the classroom well after the program had been implemented to and after the school based project assistant had left the room was supplementary to the ongoing program and for a few days provided another adult to lead two rotating groups of low achieving children. The MPS used pattern blocks to illustrate multiplication which was an activity structure not noted in observations of students with the classroom teacher or others.

The teacher felt the inservices and individual consultations with the MPS were the most valuable part of the program. However, at the school level team planning which still continued and team teaching on a regular basis with the school based project assistant has been instrumental in implementing the program.

This instance of implementation is probably not replicable in the ordinary classroom context where extra adult help is often sporadic or absent. This case study provided numerous examples of adult guidance to children in playing mathematics games and of other instances of small group instruction using manipulative aids.

Study H

Observation Schedule

Date	Day	Hours	Minutes
1/28/81	Wed.	1	10
1/29/81	Thurs.	1	
2/2/81	Mon.	1	23
2/3/81	Tues.	1	13
2/4/81	Wed.		56
2/5/81	Thurs.		59
2/9/81	Mon.	1	23
2/10/81	Tues.	1*	
2/12/81	Thurs.	1*	
2/16/81	Mon.	1	12
2/17/81	Tues.	1	27
2/23/81	Mon.		50
2/24/81	Tues.		43
2/26/81	Thurs.		30

TOTAL - Days: 14 Hours: 14 Minutes: 46

*Estimate

Classroom Ethnography Case Study
and Analysis for Research Site I

Context of the Research

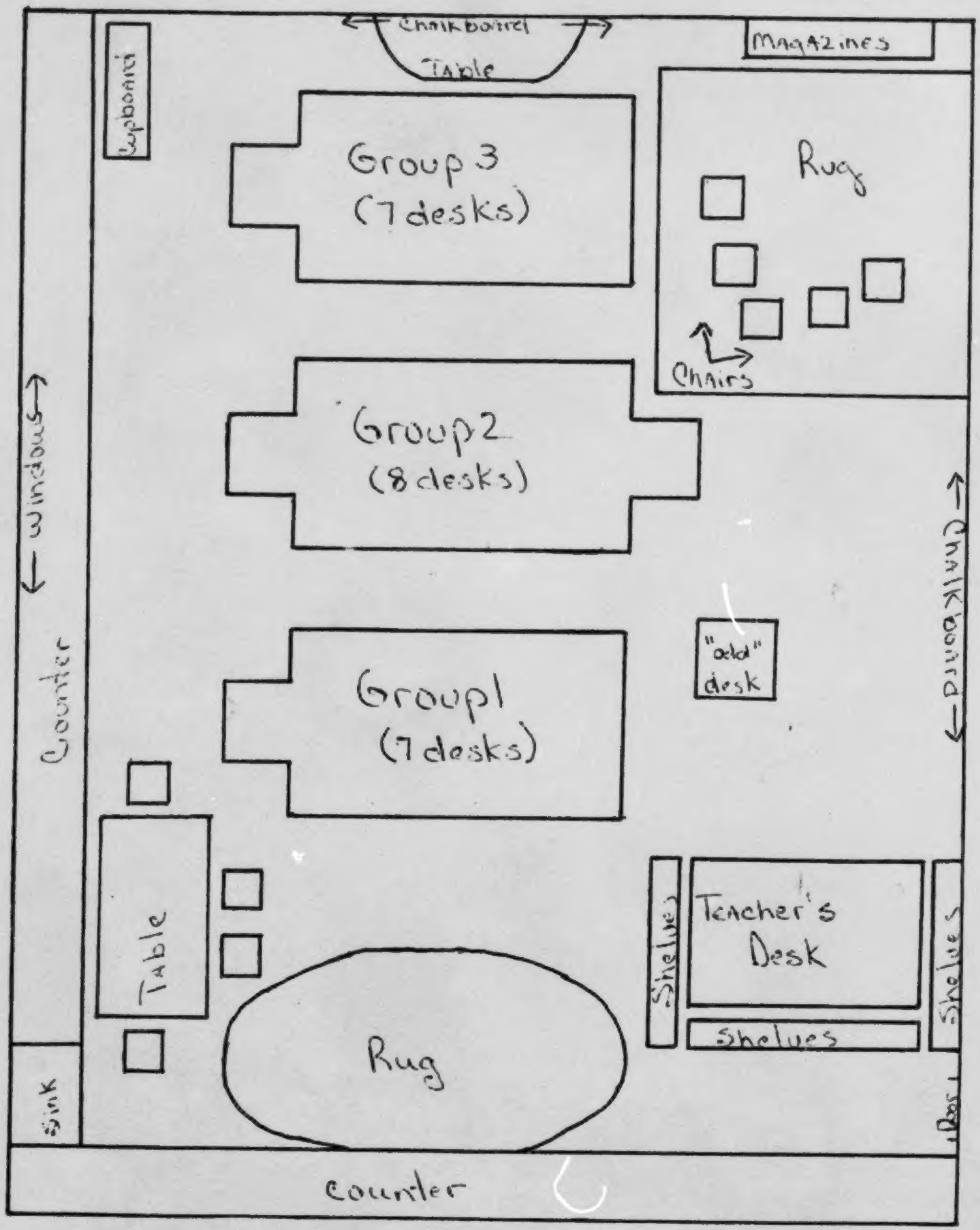
The observations at this site began in early March. The school, one of the oldest in the district, was located in the inner city in a low-income attendance area. The ethnic make-up of the fifth grade classroom was 20 Mexican American and 2 Black students. In an interview with the teacher, Robert Hernandez, he explained the sequence of math units his class had completed so far this year. They had essentially followed the textbook sequence, except that he had decided to skip over the unit on decimals (he would return to it later). At present they were immersed in the fraction unit; they were at the stage of adding unlike denominators up to one-sixteenths.

Asked if he had any special philosophy about teaching math to low-achievers (nearly half of his class were identified as Title I participants on the basis of low achievement), Mr. Hernandez explained that he had a regular routine for math lessons which he felt was effective. First he introduced the lesson to the entire group, then presented some "board work" in which volunteer children could demonstrate their knowledge of the proper method. Then he assigned the class a textbook section to complete. At this point he would go to the "rug" area (see diagram) with several children who needed extra help. Any of the other children were welcome to come and join this group temporarily if they had trouble with the assignment. Additionally, at the beginning of each math lesson the aide, Helena Calderone, took three children to another room for a special lesson. These three were "a little behind" the others. When she returned, 20-25 minutes later, she would be able to circulate through the class checking on their progress and answering their questions.

The classroom was bilingual; in fact, there were three children who were monolingual in Spanish, so Mr. Hernandez had to repeat each lesson for them. He characterized these three as "very bright"; they were at least reading up to their grade level in Spanish.

Mr. Hernandez did not know which children in his class were Title I, for math at least. Though the school had a Title I Project Assistant, she had only started in January and his contact with her had been infrequent. He had attended the Title I workshop in January on teaching fractions, but had continued with his own textbook method for the fraction unit until the children had mastered the "basics." When informed that he would not be expected to change his approach during the observation, he said, "Don't worry, I won't."

Diagram of Classroom for Research Site I


Chalkboard
Table
Magazines
Cupboard
Group 3
(7 desks)
Rug
Chairs
Group 2
(8 desks)
Windows
Counter
Group1
(7 desks)
"odd" desk
Chalkboard
Table
Teacher's Desk
Shelves
Shelves
Shelves
Rug
Sink
Door
Counter

The first observation was on a Friday, the day after the interview. The observer arrived early, during recess, so that there was another opportunity to talk with Mr. Hernandez. The teacher conveyed a sense of positivism and confidence about this class, and seemed enthusiastic about participating in the observation program--he seemed far from being a "burn out" victim.

Mr. Hernandez also mentioned that he did not have any time to plan with his aide, Mrs. Calderone. Her work day started at the same time that the children arrived, and she left as soon as class was over.

There was a large list of children's names on the blackboard that day; Mr. Hernandez said that on Fridays the children who had completed all their "seatwork" could play "educational games" for part of the day. Indeed, several of the children were on the rug playing a game during this recess period, rather than going outside with the others.

Mr. Hernandez knew that the Title I Math Specialist would be visiting his classroom soon, but he had not talked to her yet about what topics she would be covering and what the format of her visit would be. The plan was for the observer to complete three observations the week before this visit, three during her visit, and three the following week. When the children came in from recess, Mr. Hernandez took some time before the math lesson to introduce the observer to the children, and for the children to introduce themselves one-by-one to her. The observer also gave a small "speech" about what she was doing in the classroom.

Organization of this Report

This report provides a record of ten observations, in chronological order, of classroom lessons before, during and after direct services were provided to students by the mathematics project specialist. For most observations, excerpts or the entire protocol describing that days' events is given following an overview or synopsis of the protocol. An analysis of the data, prepared by the ethnographic assistant, and based on a preliminary analysis of program implementation (Slaughter and Chilcott, 1981) follows the protocols. Each protocol is dated for referencing in the summary analysis.

All names are fictitious and sometimes do not reflect ethnicity. The names of Title I mathematics project participants were marked with an asterisk. Pertinent names are listed on the following page.

Robert Hernandez : Classroom Teacher
Helena Calderone : Classroom Aide
Barb Arnold : Mathematics Project Specialist (MPS)
Jack : University Volunteer

Students identified as low achievers (Title I target students) were Jerry, Alonso, Maria, Bernardo, Richardo, Patty, Lana, Raquel, Sylvia, and Barbara. Students monolingual or very predominant in Spanish were Juan, Carlos and Felicia. All of the above students were Hispanic except Jerry who was Black.

Protocols of Classroom Observations

Overview; Day One (Friday, 3/6, 10:30 - 11:30 a.m.)

This was the first observation at this site. Part of the observation time was spent drawing a classroom diagram and trying to learn the children's names. The schedule for this math session followed exactly the teacher's usual plan, described in the observer's report of her interview with him: (1) present the assignment; (2) have volunteer children to boardwork; (3) the children who need extra help some to the rug area with the teacher, while the others work on their own, and (4) the aide takes three children who are "behind" in math out of the classroom, and then circulates among the other children when they return.

Introducing the Lesson. At 10:30 the children came in from recess. The teacher, Robert Hernandez, took a few minutes to introduce the observer to the class, asking her to explain why she would be visiting them. Then he had the children introduce themselves, but many of them seemed very shy, and said their names so quietly that they could not be heard.

After this, Mr. Hernandez asked the children to get out their math books. He went to the blackboard and drew a large square and then divided the square into nine boxes. He filled in four of the squares with fractions:

$\frac{1}{6}$	$\frac{5}{12}$	
$\frac{1}{4}$	$\frac{1}{12}$	

He explained that they were going to have to add the fractions across and down to fill in the rest of the boxes. To get the last answer, for the lower right box, they could add either way--the answer should be the same. Ernesto volunteered to do the first problem, 1/6 + 5/12. He told Mr. Hernandez he knew that he would have to change the denominator in order to add. He changed 1/6 to 2/12 immediately, and added to make 7/12. Juanita volunteered to add 1/4 + 1/12. She used the method of "carrying out" and circling the two fractions to be added, a method which (I found out later) is illustrated in the textbook. Her problem looked like this:

1/4 = 2/8 = 3/12
1/12

She added the two circled fractions, and wrote 4/12 in the proper box. Mr. Hernandez said, "Now our next step is to add 1/6 and 1/4." Miguel volunteered: he carried 1/6 out to 3/18, and 1/4 out to 3/12. Then he stood puzzling over what he had written:

1/6 = 2/12 = 3/18
1/4 = 3/12

Someone else yelled, "Come on, Miguel, you've got it." Mr. Hernandez told him all he had to do was find the ones with the same denominator. Then he circled the 2/12 and 3/12 and added. The last volunteer added 5/12 and 6/12 to get 11/12. As there seemed to be no questions, Mr. Hernandez asked them to turn to page 208 in their texts.

He asked Arturo* to read the directions for the problems in the assignment. They were problems in adding fractions, set in the context of a dart game. The idea was to find out who had won the dart game by adding their scores, which were in fractions of unlike denominators. For example: "Ann's dart hit 5/12 and 3/4. What was her total score?" Ernesto explained how they would do these problems, by changing the denominators and adding. Mr. Hernandez "spot checked" with some of the other children to see if they understood. He told four of the girls that they could come to group today for extra help, and "other people with problems can come to group, too." Before the group could start, he was bombarded with questions. The children called him by his last name: "Hey, Hernandez!" He patiently answered all their questions, and spent time repeating the directions in Spanish to monolingual children.

During this whole process, Jerry* and another boy had been at the back of the room doing a different math lesson, and Helena, the aide, was out of the room with two other boys.

Group. Mr. Hernandez began explaining the problems on page 208 in Spanish. He was shortly interrupted: two boys were having a dispute about the assignment.

Francisco: Mr. Hernandez, don't you have to do the boxes?
Mr. H. : Yes.
Francisco: Alonso isn't doing them.
Mr. H. : You follow directions. If he doesn't that's for him to decide.

Mr. Hernandez went back to explaining the assignment to his group. He was describing the method the children had demonstrated on the blackboard. He told them to do the "carrying out" work on scrap paper and then put down the answer on the paper they were handing in. The other children had settled down to work very quietly now, with only some quiet consultation.

Aide Returns. At 10:55 Helena Calderone, the aide, returned to the classroom with 2 boys. She asked them to sit at the table with Jerry*. She began to circulate among the children, answering their questions. As soon as she left them, Jerry* and the others at the table began talking about someone who had "gone into labor," and what this meant. They had their math books open, but used this chance to socialize. Jerry* said, in a voice loud enough to draw attention, "I'm past y'all by 20 pages. I'm on decimals." Helena (this is what the children call her) caught this and walked back over to the table, asking "You guys are doing decimals?" They fell back to work.

Mr. Hernandez had dismissed his group, though two of them stayed at the group area where they could use the blackboard for figuring. They were drawing the fraction "puzzles" (the 9 boxes described earlier); the one they were working on used 1/5's, 1/2's, and 1/10's. Mr. Hernandez came to check on the back table, which caused another surge of work on their part. He asked one of these boys to come to the desk to work with him. Jerry* and the other two boys began playing marbles on the oval rug near their table. The other children were still working; Helena was "summoned" from one side of the room to the other.

Mr. Hernandez noticed Jerry* playing marbles and called him to his desk, to "do a problem." Jerry* would not sit down by the desk, at which point Mr. Hernandez said, "I don't have to mess with you." Jerry* sat down and started the problem. Through this all there had been another boy, Bernardo*, standing at Mr. Hernandez's shoulder. He said in a complaining tone, "I've been waiting for a long time." Mr. Hernandez helped him with his question while Jerry* worked.

At 11:20 the pre-lunch wiggles began; there was movement and talking from the hall. The children started bringing their papers to the "Math" basket near Mr. Hernandez's desk. Helena checked to see if Mario* was finished--he was playing marbles. He was not finished; she said he would have to do math after lunch instead of going outside. He got his book back out and worked until the lunch bell.

Overview; Day Two (Tuesday, 3/10, 10:30 - 11:30 a.m.)

This second observation illustrates what happened to Mr. Hernandez's schedule when the teacher's aide was absent, and children were going in and out for band, a volunteer to supervise, *and* two observers. Mr. Hernandez reviewed the lesson about finding the common denominator from last Friday (see 3/6/81 observation) because not many children had been able to complete their assignment. The observation indicates that the children are mastering the algorithms to solve problems but have incomplete understanding of the concept of fractions.

Introducing the Lesson. At 10:30 the children entered from the playground; only slightly more than half of the usual 21 were there, however, because of band practice. By 10:35 they had their math books out and turned to page 208 once more. Mr. Hernandez drew a fraction "puzzle" on the board, saying "Last week we found solutions to some puzzles. I only got four papers. Let's go over it again." Ernesto said that to work the puzzles they were "bringing them out trying to get the denominators equal." Mr. Hernandez asked for a volunteer to come to the board to do the first step in the following puzzle:

$\frac{1}{2}$	$\frac{3}{5}$	
$\frac{2}{5}$	$\frac{1}{2}$	

Julio "carried out" 1/2 until he had 5/10, though someone whispered the last step to him from the "audience." Then he changed 3/5 to 6/10, and added them. Mr. Hernandez stressed that they need to have the same denominators, and then they could add the numerators. "Who can do the other part? Bernardo?" Bernardo* went to the board to add 2/5 and 1/2. He worked in a rather fast, scribbly, and confusing style, but he *did* come up with two fractions which could be added. He carried the 2/5 out farther than he would have needed to: 4/10...6/15...8/20, when only needed the 4/10 in the end.

He also carried the 1/2 one step too far, to 6/12, before Mr. Hernandez stepped in and asked if he could find two denominators that were the same. Ricardo* did the next part of the puzzle in a similar fashion, carrying 3/5 out all the way to 18/30, and 1/2 to 6/12 before he found the two with the same denominator. But he did get the answer, going through this process very quickly. He wrote an entire line of numerators and lines first, and then the line of denominators under them. Mr. Hernandez had Ricardo* repeat his method, "in case some didn't see." Miguel volunteered to do the last empty box in the puzzle, which meant adding 9/10 and 11/10. Instead of adding them right away, Miguel converted each of them into 1/20's and then added. Mr. Hernandez showed him he could have just added the 9 and 11. He wrote 20/10 in the empty box, they did not "reduce" this to 2. Mr. Hernandez complimented Miguel on his clear numbers. He asked the class, "How many had problems with the targets?" (the other part of Friday's assignment) Patty* and Juanita raised their hands. Mr. Hernandez said they could work on the target problems in group.

For today's assignment, Mr. Hernandez asked them to look at page 209. They would be adding three fractions for the first time. He put a sample problem from the book on the blackboard:

$$
\begin{array}{r|lllllllll}
\frac{3}{10} & = & \frac{6}{10} & & & & & & & \\
\frac{1}{4} & = & \frac{2}{8} & = & \frac{3}{12} & = & \frac{4}{16} & = & \frac{5}{20} & \\
+\ \frac{2}{5} & = & \frac{4}{10} & = & \frac{6}{15} & = & \frac{8}{20} & & & \\
\hline
 & & \frac{19}{20} & & \text{(children's work)} & & & & &
\end{array}
$$

Mr. H. : We cannot add unlike denominators. We'd have to change them some way.
Ernesto : Get the denominators the same.
Mr. H. : Right. It's the same thing we've been doing in the past.

He called on Alonso*, who had just returned from band practice, to come up and "change the denominators" on 1/4. He asked Juanita to "carry out" 2/5. She wrote 4/10 quickly and went back to her seat. Mr. Hernandez asked her to come back and carry it out one more step: she wrote 6/15 and 8/20 as well. Mr. Hernandez: Now, who'd like to do the last one? Juan volunteered--one of the Spanish-speaking children. Mr. Hernandez repeated the problem to Juan in Spanish. He changed 3/10 to

6/20 and circled two of the three fractions which now could be added. The other children noticed that he had only circled two, but he knew which ones to add. He said in English: "6, 5, and 8." Mr. Hernandez asked Raquel* to come up and add the three fractions to get 19/20.

More children came in from band practice. Mr. Hernandez briefly explained to them that they had been adding unlike denominators. He wrote a problem on the board with three fractions with the same denominator:

$$\begin{array}{r} \frac{1}{8} \\ \frac{3}{8} \\ + \quad \frac{4}{8} \\ \hline \end{array}$$

He asked, "Do we have to do anything? No--they're the same." He added them to get 8/8. Then he asked, "What does 8/8 equal?" There were a couple of guesses: 16? 1/2?, which Mr. Hernandez repeated incredulously. He drew a box with eight sections, and aksed "If we put a fraction in each box what would it be?" More guessing--until Alonso* came up with 1/8. Mr. Hernandez: "Now, if we put all the blocks together how many would we have?" The answer came: 8/8. Mr. Hernandez said that they had not been reducing their answers to their lowest forms.

The assignment was on page 239. Jerry* called from the table, where he and Jim had been working together: "I've done all of them!" One of the problems in the assignment concerned a triangle. Mr. Hernandez asked them what it was the problem wanted them to find. Ernesto and Alonso* made several guesses on the pronunciation of the word "perimeter." Mr. Hernandez: "How do we find the perimeter?" He drew a triangle on the board, showing them that it was the same 3-fraction addition that they had just been doing, i.e., each triangle side was a fraction. Mr. Hernandez said that several children were looking away," and they would be asking for help later." He repeated that to find the perimeter they would start with all the sides and add them. When he asked, "What does it mean, to find the perimeter?", Ernesto and Alonso* answered: "Add all the sides!"

Group. Somebody still did not have the page number of the assignment, so Mr. Hernandez wrote it on the board. He said that anyone who needed extra help could come to group. Jack, the U of A student, sat down by Ernesto. Three girls initially made up the group in the rug corner. Bernardo* had a question right away for Mr. Hernandez, and Carlos had his hand up, so Mr. Hernandez called him over to the group, too. He drew another fraction puzzle for the three girls, explaining the process in Spanish. He asked Jack to take Jerry* and Jim to work on a page in the book. Jerry* was playing checkers with Miguel on the counter. Jerry* was claiming that he had worked has way ahead of the class, to subtracting fractions. When Jack asked him to come, he refused. Jack tried being more insistent, but finally helped Jim instead for a while. Then Jack consulted Mr. Hernandez, and told Jerry* that the word was he would have to come as soon as he finished the checker game. The other were mostly working quietly, some on the fraction puzzles, some on the 3-fraction addition.

Mr. Hernandez left his group, saying he was going to "challenge" Jerry* to "see if he's really ready to go ahead." He asked Jerry to bring his book to the board. He gave him the problem:

$$\begin{array}{r} \frac{2}{3} \\ -\ \frac{1}{6} \\ \hline \end{array}$$

Jerry* told Mr. Hernandez how to change 2/3 to 4/6, and completed the subtraction. Mr. Hernandez said he would have to do one more to show what he was doing. It was hard to tell if Mr. Hernandez was satisfied with Jerry's* performance on this problem. Miguel was still at the counter with the checker game; as soon as Jerry* was released he headed back there, but not in time to beat out Juan for the next turn at playing. Jerry* and Julio stood watching Miguel and Juan play. Alonso* called to Miguel that he was supposed to be doing math. Jack was sitting next to Alonso* and Ernesto, so they were somewhat "trapped" into continuing with math. The two of them were discussing how fast they were getting the work done.

Mario* finally returned from band practice, and "checked out the scene." Mr. Hernandez was giving Patty* and Felicia, in the group corner, some more help, but Jim had his hand in the air. Apparently Jack did not see Jim's hand either. He put his hand down. Yet when Mr. Hernandez asked, a moment later "How are you doing, Jim?", he answered "Pretty good." Raquel* pointed out to Mr. Hernandez that she had not asked for help once during group time. He told her he was proud of her.

Mr. Hernandez encountered Mario* who still had not begun his math since returning from band. He told him in Spanish that he would have to do the assignment, but Mario* answered in English, "I don't want to, man. I was in band." He eventually relented and went to his desk, got his book, and took it to Mr. Hernandez's desk to work with him in the last few minutes before lunch.

Overview; Day Three (Wednesday, 3/11, 10:30 - 11:30 a.m.)

This protocol described the usual pattern of whole group instruction, including board work, followed by small group or individual instruction while the rest of the class completed their textbook assignment. On this day the aide was absent again and there were no other volunteers. Several selections from the protocol are presented showing the response of low achieving students to the lesson.

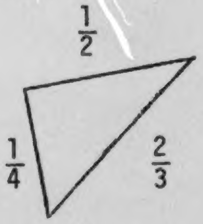
Introducing the Lesson. Just before the children came in from recess I asked Mr. Hernandez if Jerry* had really been working ahead of the class on his own. (See yesterday's observation.) He said that Jerry* did not have a clear idea of what he was doing so he had asked him to slow down and work with the rest of the class. When the children came in, he asked them to get out their math books right away. When some of the children continued to "fool around", he said, "I want every pair of eyes on Mr. Hernandez. How can we be good students if we're not listening?" He asked for attention in Spanish, emphatically, and the room got quiet. Since everyone claimed to have finished the fraction puzzles from yesterday, he said they would be able to go on to fraction subtraction today. But first he was going to review 3-fraction addition. He asked for volunteers to do the following problem, and got several:

$$\begin{array}{r} \frac{1}{4} \\ \frac{5}{4} \\ + \; \frac{3}{4} \\ \hline \end{array}$$

Out of these, he called on Ricardo*. Ricardo* started to change the denominators. Mr. Hernandez stopped him, asking "Are all the denominators the same?" He explained in Spanish that all Ricardo* would have to do was to add 1, 5, and 3. After some hesitation, and repeated instructions, Ricardo* wrote down a 9. Mr. Hernandez asked if he should add the bottom ones, but answered his own question: "No, it stays the same.". . .

. . .Alonso* asked why Juan had not changed the 5/6 to 10/12, and Raquel described how she had "run them out" into larger denominators. Mr. Hernandez asked them if they had really needed to do that. He showed them how the very first step found just the denominator they needed; they did not need to go to 1/9's or 1/12's. (It seemed that the children's mechanical perseveration in the "carrying out" process was again causing them to do extra work.). . .

. . .Bernardo* remarked (sounding peeved) that he had not been called on yet. He was sitting at his desk which was not grouped with the others but by itself in the front. When Mr. Hernandez turned to speak to the rest of the class he often had his back to Bernardo*. Mr. Hernandez drew a triangle with fractions for the lengths of its sides. He said Bernardo* could find the perimeter by adding the three sides.



$$\frac{2}{3}$$

$$\frac{1}{2}$$

$$\frac{1}{4}$$

In his hard-to-duplicate "scribbly" style, Bernardo* began writing three rows of fractions in small, crowded numbers. He had carried 2/3 out to 8/12, 1/4 out to 4/18, and 1/2 out to 5/8, and looked confused. Mr. Hernandez asked, "Are you stuck, Bernardo*?" There were quiet rumblings going around that Bernardo* was taking too long. Mr. Hernandez helped him quietly and as privately as possible, showing how he could carry the last one out to 1/12's to get denominators alike. Then he could add them.

Mr. Hernandez erased Bernardo's* work and had the class work the same problem together. They called out the answers in unison--Ernesto, Alonso*, and Francisco, mostly. Mr. Hernandez said, "OK was Bernardo* right?" Francisco: "Yeh, but it took him so long.". . .

Group. Jerry* claimed he had already done the assigned pages, and Barbara*, who had been absent, looked upset about doing the assignment. Before going to the group, Mr. Hernandez explained 3-fraction addition to her once again. Other people were wanting help, but Jerry* surprisingly said to them, "He already said to be patient. There's only one person to help us."

Mr. Hernandez called Mario* and Ricardo* to group, to work on an earlier page in the book. The page was on the basic idea behind changing numerators and denominators. Mario* would not look at the blackboard when Mr. Hernandez asked him to; Mr. Hernandez reminded him that he was behind and needed to pay attention. Mr. Hernandez put the following problem on the board:

$$3 \times \boxed{} = \boxed{}$$

$$8 \times \boxed{} = 16$$

He asked Ricardo* if he could do this problem. Ricardo* said the answer was 13. He asked Mario* if he could fill in the box for $8 \times \boxed{} = 16$. Mario* said "1," to which Mr. Hernandez countered, "One times eight equals 16?" He explained that since 2 x 8 = 16, they would put 2 in the empty box. Then they would put 2 in the other box, to make 3 x 2 = 6. He asked Ricardo* next if he could fill in the missing number in the next problem, "Four times something equals 24. What is it?" Ricardo* looked puzzled. Mr. Hernandez suggested Ricardo* look on his "little chart", which turned out to be a "6 x 6" card with the multiplication tables on it. While Ricardo* was mulling over his little chart, Felicia and Lana* asked for help with one of the perimeter problems; Mr. Hernandez drew the triangle on the board. Ricardo* came back to group and said (it now seemed out of context) that 4 x 6 = 24.. . .

Overview; Day Four (Monday, 3/16, 9:30 - 10:30 a.m.)

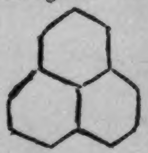
This observation describes the first of five visits of the Math Specialist, Barb Arnold, to this classroom. The format for her visit was that while the rest of the class worked on Language Arts, (as usual for this time of the morning), the MPS pulled several children at a time out for some math activities. On this day the Math Specialist did some beginning fraction concepts with two groups (11 of the 21 children).

The MPS - Group 1: Ricardo*, Jerry*, Sylvia*, Raquel*, and Lana*. Hexagon Worksheet: Barb asked these five children to come to the oval rug in the front of the room. When they were seated, she passed out a Hexagon worksheet. The pattern blocks were in four piles in the center of their circle: yellow, red, blue, and green. First she told them to cover the hexagon on their worksheets with red pattern blocks. It took two. Then she held up a yellow hexagonal block, the same size as the hexagon on the worksheet, and said, "If this is the whole, what do you call this red one?" She asked again, what they would call one of "two equal pieces." Jerry* said, "1/2." Then she asked them to cover the hexagon with green pattern blocks (small triangles). It took 6 of these. Barb asked, "If it takes 6 pieces to make the whole, what would I call this one?" (holding up one green block). There was no answer. Barb explained, "If it's one of six equal pieces, it's called one sixth." As the children removed each set of shapes, she asked them to line them up at the right of their worksheets. She asked them next to try the blue pieces (diamonds). It took 3. Barb began her usual question, "If this...," but Sylvia* said immediately, "One third."

Barb told the group to turn to the next page of the handout. There were two hexagons at the top of this page. First she asked them to show her by touching each group of shapes which were 1/2's, 1/3's, and 1/6's. Then she had them show her the fraction 2/3 in the left hexagon. She continued, "Now touch your 1/6's. Would you take 5 of these 1/6's and put them on the right? OK so now you have 2/3 and 5/6." Ricardo* had put 6 green blocks down instead of 5, so Barb stopped for a minute to set him straight. She asked them which was more, 2/3 or 5/6? Jerry* said quickly, "5/6." She asked him how he knew that so quickly, and he said, "by counting them, 1-2-3-4-5." Barb said there was another way to prove it, by placing the 2/3 on top of the 5/6 to compare. They could see that 5/6 really was more. They cleared their worksheets. Next she asked them to find 1/2 and put it on the left side, and 1/6 on the right. She asked which was greater. Lana* said that 1/2 was greater because it "covered more." "So," Barb emphasized, "1/6 isn't bigger just because it has a bigger number." Similarly, Barb asked them to compared 1/3 to 1/2. Jerry* thought 1/3 was greater, but Barb showed him that 1/2 was actually greater by placing the two shapes together. She said, "Fractions are tricky. The numbers fool you. You have to think of pieces instead." Then they compared 2/6 and 1/2; again, Jerry* thought that the smaller fraction was really greater, until they compared the blocks.

The group had gathered an audience of Ernesto, Mario*, and Alonso*. When Barb asked them to compare 2/3 and 4/6 with the pattern blocks, Ernesto interrupted to show that someone had only used 3/6. Barb asked him to please just watch. Raquel* showed that these fractions were the same because "the same amount was missing," i.e., the uncovered part of the two hexagons were the same. Lana* at first disagreed, but she had an extra 1/6 on her worksheet. Raquel* lined her shapes up on top of each other to prove that she was right. Ricardo*, at Barb's far right, did not seem to be entirely tuned in to all this. He was moving his set of pattern blocks around intently, lying on his stomach with the blocks about an inch from his nose.

"I Can't Believe I Made the Whole Thing" Game. Barb asked them if they remembered the game she had brought the last time; Jerry* at least did. She passed out laminated game boards with the outlines of three hexagons in a "pyramid," like this:



Barb showed them a die with fractions printed on its sides. She explained that they would fill their hexagons in by taking the shapes which they rolled on the die: 1-yellow, 1/2-red, 1/3-blue, or 1/6-green. She also showed them how a combination of a red, blue, and a green could make a whole hexagon, and asked them to "read" this "fraction sentence": 1/2 + 1/3 + 1/6 = 1 whole. They rolled for "first turn," the one to roll the "biggest piece." Barb reminded them that there was a rule to always shake the die, as someone really didn't. Ricardo* was third. When he rolled 1/6, he grabbed a red shape. Barb asked him, "Is that 1/6? Look at your pattern blocks. Where do you have 6 equal pieces?" He traded the red for a green. Barb intorduced two more rules that she "forgot at the beginning": they would have to name the fraction before they could take a shape, and that they could not move the shapes once they had placed them. The game when on accordingly until Raquel* filled one whole hexagon, with three 1/3's. Barb stopped the game to show how Raquel* could trade for one whole yellow hexagon. Next Sylvia filled a hexagon with two 1/3's and two 1/6's. The game slowed down as this happened more and more, and, as Barb pointed out, "You're getting stuck and can't find places for your shapes." Ricardo* was at the point of only needing 1/6 to "win," so that he had to pass when he rolled 1/3. He won on the next round. Barb had this group go back to their seats so that she could call another group.

The MPS - Group 2: Francisco, Ernesto, Juanita, Patty*, Barbara*, and Mario*. Barb said that this group would have to hurry as she had just found out from Mr. Hernandez that recess would start at 10:15. The same activities were repeated with this group.

Overview; Day Five (Tuesday, 3/17, 9:30 - 10:30 a.m.)

During the second day in the classroom, the MPS worked with two new groups, the three monolinguals and a small group of boys on the same hexagon worksheet and games used the day before. These activities were attractive to other students who tended to watch when they could. The students in the groups seemed to perform the tasks very easily and after class the MPS talked with the teacher about selecting students who were still struggling with fractions concepts. At the end of each group session, the MPS played a game with the group, as the following excerpt shows.

Game: I Can't Believe I Made the Whole Thing. . . .She named the yellow "whole" hexagons "gold" at the beginning of this game, playing up the "miser" role she had used yesterday to make the game more entertaining and fun. When they heard this, the boys made up "valuable" names for the other shapes, too: sapphires, diamonds, etc.

When it was Bernardo's* turn, he did not really "shake" the dice, and Barb reminded him that it was only fair to do so. The game proceeded otherwise smoothly, with the boys enjoying Barb's miserly banker role. This role-playing brought extra excitement to the most mathematically important part of the game: trading for whole hexagons. Barb again asked this group to tell her in a fraction "sentence" what fractions they were trading for her "gold" pieces.

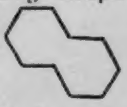
Jim won the game, and there was just a short time left before recess to clean up. Barb asked the boys what they thought of pattern blocks. They said they were "fun." Bernardo* added that "The only reason I like them is they're fractions. My dad and I when we're measuring use fractions." Julio and Arturo, however, said they thought fractions were "hard," especially subtraction (their current textbook lesson). When the bell rang for recess, Bernardo* stayed briefly to ask Barb where she got the pattern blocks, and if he could buy them somewhere. She said maybe she could leave some for the class to use.

During recess, Barb talked to Mr. Hernandez about dividing the groups so that she could work more with the children who were still struggling over basic fraction concepts, like Ricardo*. She expressed how pleased she was with how well Bernardo* performed on the pattern block activities.

Overview; Day Six (Wednesday, 3/18, 9:30 - 10:30 a.m.)

In this observation Barb, the Math Specialist, tried some new fraction addition techniques with five children during the hour spent in the classroom. She was following a book called "Fractions with Pattern Blocks." It was an experiment in getting the children to see that the pattern blocks could represent any fraction, i.e., green is not always 1/6. By using a bigger "whole", she changed green to 1/12. This activity was performed easily by the group. Then for the game at the end, she changed the values of the pattern blocks back to those of the previous day. The game was more difficult and required some teacher assistance. She said at the end of this session that she would not do this "switch-back" with another group, as it might be too much confusion for one lesson. Note especially that Ricardo* was more tuned in today than on Monday.

Fraction Addition: Barb took a group--Ricardo*, Ernesto, Arturo, Barbara*, and Juanita-- to the oval rug while the others worked on language arts with Mr. Hernandez and Helena, the aide. She told them she was going to try out some new ways of teaching adding fractions. Each child got a small chalkboard, some chalk, and two yellow hexagons. Barb told them to place the hexagons side by side on the chalkboard to make one big shape, and then to draw around this shape with their chalk:



Barb explained that all the values for the pattern blocks would now be changed. The yellow blocks would equal 1/2 instead of 1. They would have to "shift gears," to think of the blocks in a new way. "Now how many red pieces will it take to cover the shape?" They covered the shape to see the answer: 4. Then she had them cover the shape with blue pieces. "What will you call each of the six equal pieces?" "One sixth": she said this and wrote it on her chalkboard at the same time. Then she asked them to compare 3/6 and 1/2, using the blue and yellow shapes. The children could see that they were equal. Then she asked how many green triangles it would take to cover the shape. Ricardo* said quickly, "Twelve." Once again, she asked this question as she wrote the fraction on her chalkboard: "What would you call one of the twelve equal pieces?" She wrote this so that the word "one" coincided with the writing of the number 1, the fraction line with the word "of," and "twelve" with the number 12 under the line. Next she asked them to place 7/12 on the figure. Ricardo* contributed, "It would take 5 more to cover it." Then they did 10/12. Barbara* had a difficult time fitting the triangles inside her figure, but Barb said it was OK for her to look at someone else's to see how they did it. "It's not called copying if you share ideas."

Barb said, "Now I'm going to write a problem. I want to add 3/12 and 3/12." When they had placed the total of 6/12 on their figures, she said, "Look--it's the same as this shape (Yellow). What did we call this one? 1/2. So 6/12 equals 1/2." She explained that it was hard today because all the shapes had different values from yesterday. She showed them how, if she had made the red equal to 1, the green would equal 1/3. It all depended on which shape they picked to make a whole.

Barb asked the children if they thought they could add three fractions. (They had already had a textbook lesson on this.) She wrote a problem on her chalkboard: 4/12 + 1/12 + 3/12. Ernesto and Arturo immediately added to get 8/12. Barb explained that they did not need to add denominators. They were all the same; they told the "name of the piece." They should add the top number--the numerator--because that tells how many pieces. She told them to erase the shapes from their chalkboards and write down the following problem: 6/12 + 2/12 + 1/12. They were supposed to add their fractions numerically. Barb was going to do the problem with pattern blocks, to see if she got the same answer. . .

Card Game. It was called "I Can't Believe I made the Whole Thing," the same name as the game they had played Monday and Tuesday with pattern blocks, but this one was a card game. She told them that she had made this card game for their class. It was in a manila folder with the directions printed on the outside so they could play it again by themselves after she left. Each card was printed with a fraction and a picture of the fraction as it would look in pattern blocks with the yellow hexagon as "1." This meant they would have to shift back to thinking of red as 1/2, etc. The object was to collect fractions with the same denominator to make "wholes," which could then be "laid down" as in rummy. It also had a rummy-like draw-and-discard pattern. Each child got seven cards to start. It seemed to take the children a while to catch on, especially Juanita and Barbara*, who looked confused. Ricardo* lined up pattern blocks on his cards to "see" what he had. These three needed Barb's help to decide what to do with their hands. Ricardo* kept shuffling his cards and looking them over, but not indicating that he knew what he was looking for. Juanita tried to lay down 2 1/6 cards, but Barb explained that that did not make a whole thing. . .

. . .After the group left for recess, Barb asked Mr. Hernandez if she could come for two more sessions next week, on Wednesday and Thursday. She felt she wanted to work with more of the children, especially since only one group got to try out the new activities today. She told me on her way out that when she first got the Math Specialist job she told the other MPS's she could not teach fractions, but now she was really enjoying it.

Overview; Day Seven (Tuesday, 3/24, 10:30 - 11:30)

This observation was of a regular math lesson on graphing during the week after the mathematics specialist's visit. The lesson consisted of demonstration of graphing techniques on the board for the whole group and then dividing the class into three groups, one with the teacher and one with the aide and one with Jack, the student volunteer. Teacher and aide helped students complete workbook problems requiring the reading of graphs, while Jack had students construct their own graph.

Overview; Day Eight (Wednesday, 3/25, 9:30 - 10:30)

The math specialist had returned to the classroom for two more sessions this week to try out some new worksheets, developed the previous day in conjunction with the other math specialists, to help children understand why a common denominator was needed to solve fraction addition problems (Appendix A). Materials brought into the room by the MPS included worksheets, cuisenaire rods, and masonite boards (9 x 11) for children to work on while at the rug. The MPS first reviewed the units represented by each of the rods before doing the activity. The classroom teacher and MPS talked about time needed to complete each groups activities during the session and afterwards briefly discussed the activities of the children and MPS. The MPS told the teacher she would leave a fractions folder with him the following day.

Overview; Day Nine (Thursday, 3/26, 10:30 - 11:30)

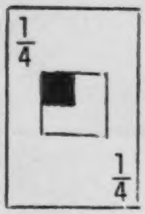
This was the fifth visit of the Math Specialist to the classroom. She worked with three small groups: one for a cuisenaire rod activity and two for card games. The second card group was bilingual, since two of the monolingual children were members. Ricardo* a target child whom she especially hoped to reach, was more fascinated with the rods than with the activity (he had a similar response to the pattern blocks last week). Both activities required a lot of teacher guidance, especially the game activity.

The MPS - Group 1: Ricardo*, Lana*, Julio, Arturo, with Sylvia* and Mario* observing. Barb passed out the small chalkboards, which they were to use as flat work surfaces for the cuisenaire rod activities. They emptied the boxes of cuisenaire rods in the center of their small circle (they were sitting on the oval rug near the counter). Then she passed out worksheets titled "Cuisenaire Rod Fractions". Holding up a dark green rod, she said that it was going to be the "whole thing." She placed this rod across the top of the grid at the top of the worksheet, and asked the children to do the same. Then she placed two light green rods below the green rod in a "train," and the children followed. She asked, "What do we call the light green?" Julio answered, "One half." When she asked him to explain why, he answered, "Because it was a whole one and you cut it in two pieces." She asked the children to hold up first one 1/2 and then two 1/2's, saying "What's another name for 2 halves?" Raquel* replied, "One third." Lana* guessed, "One and a half." Barb said, "Can you see that its the same as one whole?", and lined the light green rods up under the dark green rod again. She asked them to please line up the red rods in a train below the light green rods. When they were finished, she asked, "How many did it take?" Lana*, anticipating the next question, answered, "One third." Barb asked them to hold up first one third, then two thirds, and then three thirds, saying, "What's another name for three thirds?" Raquel* ventured, "One half." Barb said to compare three thirds with the light green rod; they were not the same. She said, "Look at your design. What block is the same as the three red ones?" Raquel* replied, "The green one!" While this process was going on, Ricardo* had been "playing" with the piles of rods, making designs on his own, and attending only slightly to Barb. Barb continued, "Let's use the white ones. How many will it take?" Lana* answered right away, "Six", and the responded also that one of these would be called "one sixth."

Barb : Get two white ones right out of your design. (She called the grid with the rods arranged in it the "design") Hold them together. Can you find one just like them?
Raquel*: Red.
Barb : What is it?
Raquel*: One third.
Barb : Then hold up three white ones. Which one's the same?
Lana* : Light green.
Barb : What is it called?
Julio : One half.
Barb : Now we're going to do something really tricky. Put your finger on the second group of squares (on the worksheet).

Barb asked them to read the problem aloud together: "One half plus one third." She had to remind Ricardo* to pay attention. The design he was creating with the extra rods was getting to be very complicated, and he was very absorbed in it. He was lying on his stomach at Barb's far right, with his face close to his pile of rods, out of her direct line of vision. This was the same position he had chosen last week for the pattern block activities. Barb asked them to take a light green rod and line it up in the top row of the seoncd group of squares on the worksheet. "Now which one will be one third?" Lana* held up a red rod: "This one." They lined the red rod up in the same row next to the light green rod. Barb explained, "I can't add these because they're not alike. I have to give them another name so I can add them. I'm going to use white rods." First they "measured" the light green rod by placing white rods below it in the second row of squares. Barb said, "It takes three. So that would be three sixths." Then they measured the red rod, which took two white rods. "So how many did it take to do it altogether?" Five. "Sooo.." Barb began, turning to Ricardo* and grasping his hand, speaking directly to him to draw his attention, "One half and one third are five sixths." They removed the rods from this problem. The next problem was 2/3 + 1/6. . .

The MPS - Group 2: Barb said that she had some card games to try out, if Mr. Hernandez wanted to choose a new group to play. He called Sylvia*, Jerry*, Bernardo*, and Jim. Barb asked Mario* to join, also, since he had been watching the last group so intently, but he declined. Sylvia* changed her mind about being in the group--something else seemed more interesting--so Alonso* took her place. Barb told them that the first game was called "War." Jim said, "Oh, yeh, whoever has the highest fraction gets all the cards." Barb passed out seven cards each. Jerry* said that they should count the cards to make sure they all had the same--sure enough, he and Alonso* had one extra card, which they put back in the "pile." Barb told them they should stack their cards face down, without looking at them. They would just flip over the top card and then see who had the largest fraction. That person would win them all. The cards had not only written fractions but also pictures of squares with portions colored in:



Therefore, they could judge who "won" not only numerically but also spatially, by comparing the colored-in areas. Barb reinforced the numerical aspect by asking them to name their fractions aloud as they turned them up. On one of the first rounds, Jerry* thought he had won with 5/8 over 3/4. He began to grab up the pile, but Barb said they would have to stop and look more carefully. In this case, the shapes made the decision; they could see by comparing which was larger. Someone complained that he was not doing too well so far, to which Barb replied that "Sometimes you get a lot of good cards. It's luck." The next "tricky" turn came when 3/4 was up against 6/8. Barb said, "Wait a minute let's look at the shapes." Alonso* said, "They're the same!" This was true, so they had to play another round to break the tie. Barb stopped the game after only five minutes, before there was any decisive "winner," so that they could try another game.

One. Alonso* said, "Uno! I know that game." But this game was different from the One game they had in their classroom. Once again, Barb dealt out seven cards each. Alonso* said that this time they could look at their cards. He saw Lana* watching and pointed out to her that his group got to do card games. Lana* wanted to know why, to which Barb replied that she had been "doing something different" with Lana's group. The game rules for One were the rummy pattern: take a card from the pile, or the top discard, and try to make a "whole" to "lay down." This would go on until someone "went out." To start out, Barb waived the rule for "no looking at anyone else's hand," so that she could use Alonso*'s hand for an example. She showed the others that Alonso* had 7/8 and 1/8 which could add up to a whole. Then he had to discard "something he doesn't like." Arturo and Ricardo*, who had been in Group 1, stood nearby watching. Barb asked Jim if he thought he could make a whole from his hand, but he replied, "I can't." Barb asked Jim, "Since we're just learning can I look?" Jerry* accused her of "Peeking" and "cheating," but she said it was fair because they were still learning. Jim was right; he could not play. Bernardo* had 6/8 and 1/4. Barb showed the group by comparing the shapes on the cards that this combination would work to make a whole. When it was Jerry*'s turn, he had two "whole" combinations, but Barb told he could only play one at each turn. She reminded them that they could pick up the discard if they wanted, and Jerry* said, "Oh, how come you're saying that now?" Apparently he felt he had missed out on a good chance. Barb told him that sometimes learning the rules was hard. . .

Overview; Day Ten (Thursday, 3/26, 10:30 - 11:30)

After the math specialist had left Mr. Hernandez said he was going to give the class a test on fractions to see how they would perform now compared to before her visits. He offered to share the results of this test with the observer the next day. This observation, therefore, was not of a regular math lesson but of the test-taking. It was interesting to see how the target children behaved during the test, especially Jerry* and Mario*. While they were taking this test, Mr. Hernandez also shared with the observer the results of the previous fraction test. The results of this test and the one taken today are written up in a separate report in Appendix B. This observation covers test-taking behavior rather than performance.

The Fraction Test: Bernardo* came in from recess early, got his math book out of his desk, and started writing problems on the blackboard. He may have overheard Mr. Hernandez say that he was going to give a fraction test, since the problems he chose to practice were fraction addition and subtraction:

$$\begin{array}{rcc} & \frac{1}{2} & \frac{3}{6} \\ + & \frac{2}{3} & \frac{4}{6} \\ \hline & & \frac{7}{6} \end{array} \qquad\qquad \begin{array}{rcc} & \frac{1}{3} & \frac{4}{12} \\ - & \frac{2}{4} & \frac{6}{12} \\ \hline & & ?? \end{array}$$

On the first problem, he touched the numerators, 3 and then 4, with one finger, and then wrote the answer. The second problem was discouraging--how to subtract 6 from 4? He wrote an illegible answer and went back out to recess. I decided to spend a few minutes on the playground myself. When I got outside there was

Bernardo* sitting on the steps, watching some other children play kickball. Juan came up to him and sat down, teasing him in Spanish about being "fat," asking me if I agreed that Bernardo* was very fat. Bernardo* looked embarrassed and angry. When the bell rang the class went back to the room but several left immediately for orchestra. There were only 10 left.

When everyone was seated, Mr. Hernandez said, "Boys and girls let me have your undivided attention." He explained to them that he was going to put some problems on the board like ones they had done "a couple of weeks ago." He instructed them not to look on anyone else's paper--"This is a test." Suddenly Miguel, Jerry* and Ricardo* came in, saying that they were late because they had broken a window during recess. When they had settled, Mr. Hernandez said he was going to see "if the help that Miss Arnold (the math specialist) and Mr. Hartley (Jack, the U of A student) and I gave you helped you with your fractions." He said he was going to put 22 problems on the board. When they were finished with these, they could find something quiet to do. Bernardo* asked him again how many problems and if they were fraction problems. Mr. Hernandez said, "So many of you made mistakes last time I want you to work more slowly. Make sure you look at the sign to see whether to add or subtract." He passed out paper and scrap paper, and then began writing the problems on the board. After he had written the first problem, Jerry* exclaimed, "Gosh!" Several groaned. Mario* simply moaned, "Hernandez!" Raquel asked him if the problems were "add or take away," to which he replied, "What did I just say, to look at the sign." It turned out that there were 20 problems instead of 22: 10 three-fraction addition, all but one with unlike denominators; and 10 subtraction, all with unlike denominators. As soon as Mr. Hernandez had them all written on the board, Mario* went up to talk to him. He looked slightly miserable. Mr. Hernandez tried to encourage him with, "You did pretty well last time," and explained that he needed to get the same number on the bottom and then add. Most of the other children fell right to work. Barbara* stared into space and (I imagined) accusingly at me. She left her desk and asked Mr. Hernandez if she could get a drink. Mario* had come back to his seat but instead of working on the test he was lying down across three desk seats looking at the ceiling. Barbara* called Mr. Hernandez over to her desk. When he came over, she said, "I can't get number two." He explained to her that it was a test, and told her just to "do the very best you can." Miguel, who had been absent frequently in the past two weeks, seemed to be working on something different. Mario* got up and wandered around the room for a while and then laid down across the seats again. Mr. Hernandez circulated around the room.

Alonso* and Lana* came back from orchestra. They were chattering when they came in but became suddenly quiet when they realized that the room was completely hushed. Mr. Hernandez explained what was going on and they got some paper and started working. They were supposed to do their work on the scrap paper and only put their answers on the test paper to hand in. Mr. Hernandez tried to encourage Mario* once more, telling him if he had trouble with the three-fraction problems he could go on to the second half of the test. The subtraction problems only had two fractions. Bernardo* was concentrating very hard, counting on his fingers. Lana* complained to Mr. Hernandez that she has having a rough time; he told her to do her best and they would go over the problems afterwards to see what they had trouble with. When he circulated back to Mario* again, Mr. Hernandez finally convinced him to start the test. Mario* began working on the fraction subtraction problems, making marks with his pencil on his desk which he counted and then rubbed off. Julio was the first to hand in his paper. Jerry* handed in his paper, also. They got a game to play together. Ricardo* meanwhile set aside one piece of paper and got another. He told Mr. Hernandez not to erase the board, as he was still copying the problems. He would look at the board for a while, turn around (his back faced the board) and write on his paper, turn back around to look at the board, and then erase something on his paper, over and over. It was hard to be sure, but it seemed that just copying the problems from his vantage point was hard for him.

Bernardo* had to go to his "special class." He put his paper in his desk and started to leave, but Mr. Hernandez told him to hand in what he had finished so far, which didn't look very extensive. Mr. Hernandez brought me a stack of papers from the last fraction test to look over (see special report on the tests), so that I could compare today's work with some reference point. Then he went back to circulating around the room. He advised Barbara* not too spend too much time on one problem, and then announced this same advice to the entire class: "If you're stuck, go on."

Mr. Hernandez said that it was time to hand in all the papers. Lana* and Alonso* complained that they had come in late from orchestra and hadn't had time to finish. He told them they could have more time later to work on it. Jim begged, "Hernandez, Hernandez, Pleeeeease?" But Mr. Hernandez said, "Sorry--time is up." He told them they could get some games to play until lunch. The next day was going to be a "teacher planning day"; the children would not be in school. Mr. Hernandez told me that if I wanted to come in to see the results of this test in the morning he would have them graded. This was my last observation of the class in session.

Case Summary and Analysis

This summary will focus on the emergent themes suggested in a preliminary report of the overall findings on program implementation, (Slaughter and Chilcott, 1981), followed by a section on the evidence for the effect of the MPS intervention in this classroom.

Ambiguity. The preliminary report discussed the ambiguity in the teacher's perception of the MPS role. Evidence from this case study indicates that Teacher I perceived the MPS as an "enrichment teacher," and her program as a supplement to the "basics" of a textbook-based program. In the context of this perception, the MPS would come into the classroom to work with children who need extra "help." These are the factors which contribute to such a conclusion:

1. In an initial interview with the observer (3-5), Teacher I expressly stated that he was "saving the games from the workshop." (i.e., the math inservice) until after the children had mastered the "basics" from the textbook. Yet the emphasis in the January workshop on fractions which Teacher I attended, was on using the suggested games and manipulable materials first, before introducing the textbook lesson.

2. While the MPS was in the classroom, Teacher I and the aide conducted their regularly-scheduled language arts activities rather than either observing the MPS (demonstration model) or coordinating their program with hers (team-teaching model). The teacher helped the MPS select small groups of children for her activities, and asked her "How did it go?" at the end of each session, but did not seem to view the MPS's approach as a model for his own math program, which continued as usual. In other words, the MPS was there for the children, not for the teachers. (3-16)

3. There was little coordination between the MPS's classroom presentation and the regular math lessons. The MPS program focused on basic fraction concepts, while in the regular math program the class had completed the textbook unit on fractions the week before, and were now working on the graph unit. The MPS program, therefore, was a review of, rather than an introduction to, fractions.

4. Teacher I stated on the observer's final day in the classroom that he wished the MPS would spend more time in the classroom helping the children. (3-27)

Conditional Collaboration. The MPS visit was handled in a very relaxed fashion. The children knew her from her previous visit to their classroom, and perhaps the format for her visits had been negotiated at that time, as well. The key word would be "unobtrusive."

1. The MPS certainly did not have "center stage" during her visit. Rather than the regular "group" corner she quietly confined her activities to an oval rug on one side of the classroom, which left the remainder of the classroom for "business as usual."

2. There were virtually no instances in which the teacher intervened in the MPS's groups, but then the MPS--a skilled teacher with much appeal for the children--had few group management difficulties. This is in contrast with the teacher's handling of a small group conducted by a volunteer teacher in another observation (3-24). There seemed to be a sense of trust between the teacher and the MPS, that she would handle her group independently. The teacher did allow children with "free time" to observe the MPS's group, apparently leaving it up to her to decide if this was disruptive. There is only one instance of an observing child interrupting the MPS's group, which she managed casually. (3-16)

3. Regarding the number and length of MPS visits, the teacher was open. The MPS had originally scheduled only three visits, but she was dissatisfied with the number of children she had reached and the amount of program material she had "covered." She asked Teacher I if she could return for two more visits the following week, to which he readily agreed.

Predominance of Classroom Organization. This topic has been partially addressed already. In addition:

1. The teacher continued with his usual classroom schedule, as mentioned.

2. Teacher I does not "place" his students into formal groups for math at least. The MPS's small instructional groups were chosen impromptu, depending on who was available and the fairness of "taking turns," but with a predominant number of target children. There was some discussion between the teacher and the MPS about grouping children

for her program who especially needed basic review of fraction concepts, but this intention did not seem to be carried out systematically. (3-17)

3. Though the teacher was ostensibly conducting language arts lessons during the MPS's visits, they were not so structured that personnel rotation to form new MPS groups disrupted his program. Most of the children were doing "seatwork" and a few were freely but quietly circulating, while the teacher and aide worked with small groups. Since the observer did not observe a regular language arts time, it is hard to tell if this flexibility was an accommodation to the needs of the MPS.

Team-Teaching Not Demonstration. As mentioned earlier, the teacher and MPS at this site followed neither of these models during this series of observations.

1. There was a very brief sharing between the MPS and the teacher of the materials she had used and feedback about specific children's responses at the end of most visits. (3-26)

2. An interesting finding (which also contributes to the conclusions on "Ambiguity") was that the MPS made instructional materials for this classroom, to leave with the teacher. She informed two groups that she was leaving the games with their teacher, and explained to them how to use the games when they were playing on their own. (3-18) It is the observer's understanding from the inservices that the usual practice is for the MPS to instruct the teacher in the making of games, etc., often providing needed raw materials, but that most of the teachers were expected to make their own. The MPS in this case took extra responsibility to insure implementation of program goals in a classroom where the teacher did not follow-through on his own. This behavior on her part could reinforce the "enrichment teacher" image once again.

Teacher Evaluation of the Innovation. Without prompting from either the MPS or the observer, Teacher I decided to replace his usual math lesson on the final day of observation with a paper and pencil test on fractions. The children had been given a similar test two weeks earlier at the end of the fraction unit. Moreover, the teacher explicitly presented the test to the class as an evaluation of the MPS's intervention (3-26). The children, perhaps sensing the artificiality of this situation, did not respond well (3-26), and the results were inconclusive (see Appendix B for report on the test following observations). The children did not in general perform as well as they did on the earlier test, but this could have been due to factors in the test-taking situation (3-26). A significant finding--which may help account for this teacher's view of the MPS program as something "extra" and perhaps unnecessary--is that many of the target children (6 of 9) did well on the first test, as well or better than many nontarget children. The teacher could explain the "failures" through some idiosyncratic factor--learning disability (Bernardo), behavior problem (Jerry), test phobia (Mario) or stress (in general)--and therefore evaluate his textbook-based program as essentially successful. If this were the case, the teacher's motivation for adopting the innovations suggested by the MPS would be reduced.

Evidence of the Effect of the MPS Program in this Classroom. The math inservices emphasized certain teaching methods which are relevant to this classroom case-study. Specifically, the MPS's advocated the position that children would not understand the meaning of math concepts unless they first had a chance to demonstrate it for themselves through the use of concrete manipulable materials. This idea was presented not as a special technique for teaching children with learning "problems," but as a general characteristic of all human learning. In addition, there were implications that the "child-appeal" of these materials contributes to their effectiveness and that these materials are conducive to use by children independently or in small groups, and therefore would fit with a more "open" than traditional teacher-centered classroom structure.

1. In this classroom there was little evidence of the use of manipulable materials; math was a paper-and-pencil or blackboard activity. According to the teacher, the children had access to educational games on Fridays, if all their seatwork was completed. Teacher I's teaching method relied heavily on the textbook and workbook, which the MPS's believed were several abstract steps above the optimal starting place for meaningful learning of math concepts (3-6). The classroom was not organized for access to manipulable materials. Children who finished (or avoided) their work were allowed to "find something quiet to do." Checkers, marbles, and drawing pictures were observed. There was nothing regularly organized for such times. There were no designated areas where instructional materials were accessible to children to use independently.

2. Teacher I emphasized "paying attention" to his explanations as a key to success in math, and said that "not paying attention" was the reason for some of the children needing

more "help." He and the aide were never begrudging of giving extra help, patiently and repeatedly if need be. (Small class size--21 or fewer--made this possible.)

3. The observations (3-10), show target children who are either confused about basic math "facts" or intent on mechanical perseveration in a problem-solving method without understanding why that method works. The teacher seemed dismayed at some of the unlikely guesses the children offered in response to his questions about the meaning of fraction problems.

4. The MPS emphasized the techniques presented at the inservices (3/16/81). She began by comparing concrete shapes in certain proportional relationships with each other, explaining why these relationships were represented as fractions, and showing that the shapes could be used to "prove" mathematical calculations with fractions.

5. There was direct and indirect evidence of the appeal of MPS instructional materials and techniques (3-16, 17). The MPS activities attracted the children, some of whom gathered around her group to observe, sometimes in hopes that they might be asked to join.

   Target Child Response: Special note should be made of positive target child response to the MPS (3/16-18). Ricardo* was fascinated with the pattern blocks and rods, almost distractingly so. He became so absorbed that the MPS had to draw his attention back to her activity. Mario*, a usual math "avoider," was excited by the MPS's "dramatic" approach to the games. Bernardo* wanted to know if he could purchase some pattern blocks of his own.

6. Little evidence in the data that the MPS visit modified the teacher's approach. Earlier discussion of program implementation themes speculates why this may be so. Teacher I is considered an experienced, successful, respected teacher. He has a positive regard for the MPS and was cooperative with her and enthusiastic about his participation in the ethnographic project. The fact that his classroom appears to exemplify the near-reverse of the MPS inservice recommendations does not seem due to active resistance on his part to new ideas, but perhaps a feeling that what he does works. In addition, the reinforced misperception of the MPS as an enrichment teacher may contribute to this lack of effect on the structure of the classroom program.

Study I

Observation Schedule

Date	Day	Hours	Minutes
3/6/81	Fri.	1	
3/10/81	Tues.	1	
3/11/81	Wed.	1	
3/16/81	Mon.	1	
3/17/81	Tues.	1	
3/18/81	Wed.	1	
3/24/81	Tues.	1	
3/25/81	Wed.	1	
3/26/81	Thurs.	1	
3/26/81	Thurs.	1	

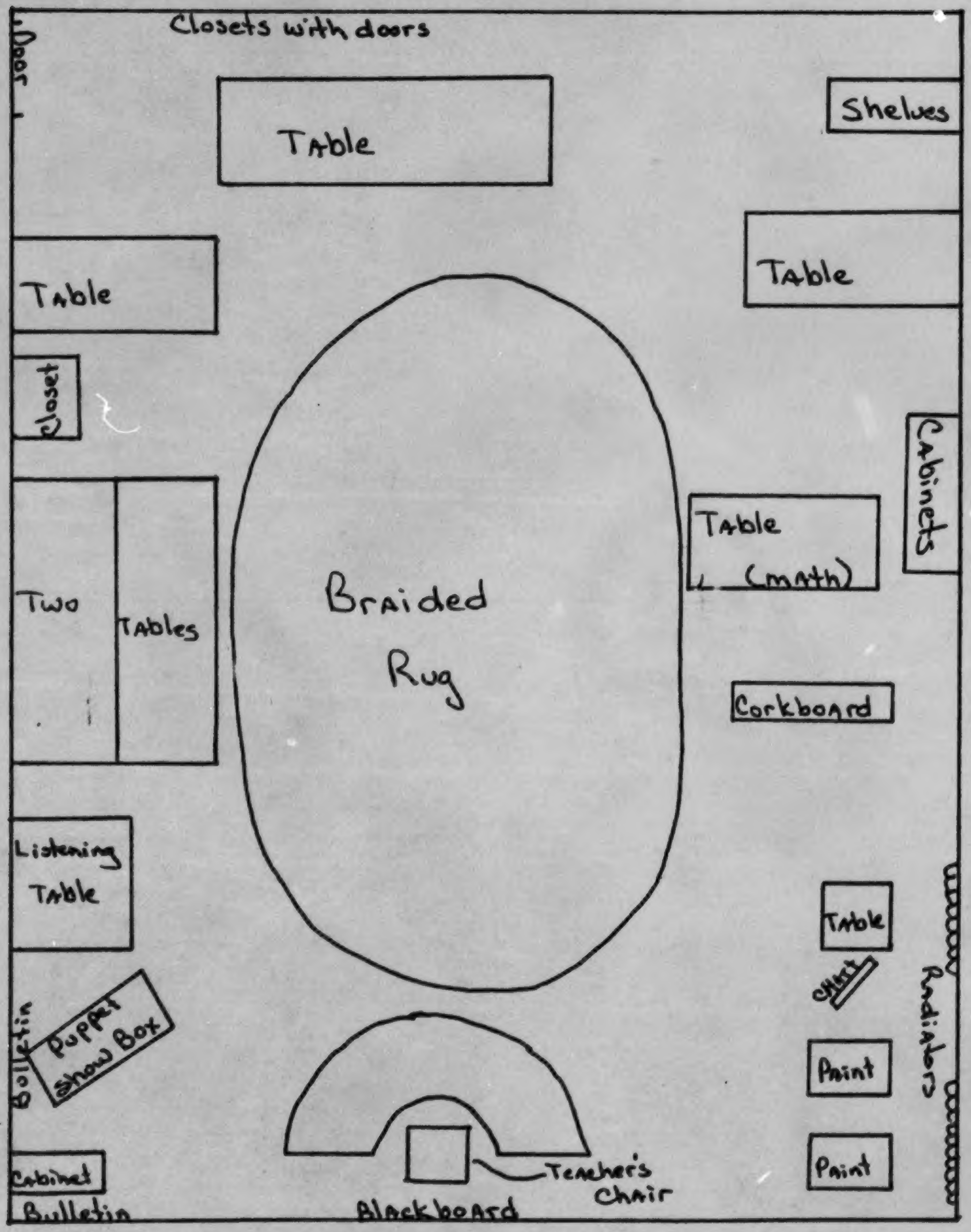
TOTAL - Days: 10 Hours: 10

APPENDIX A

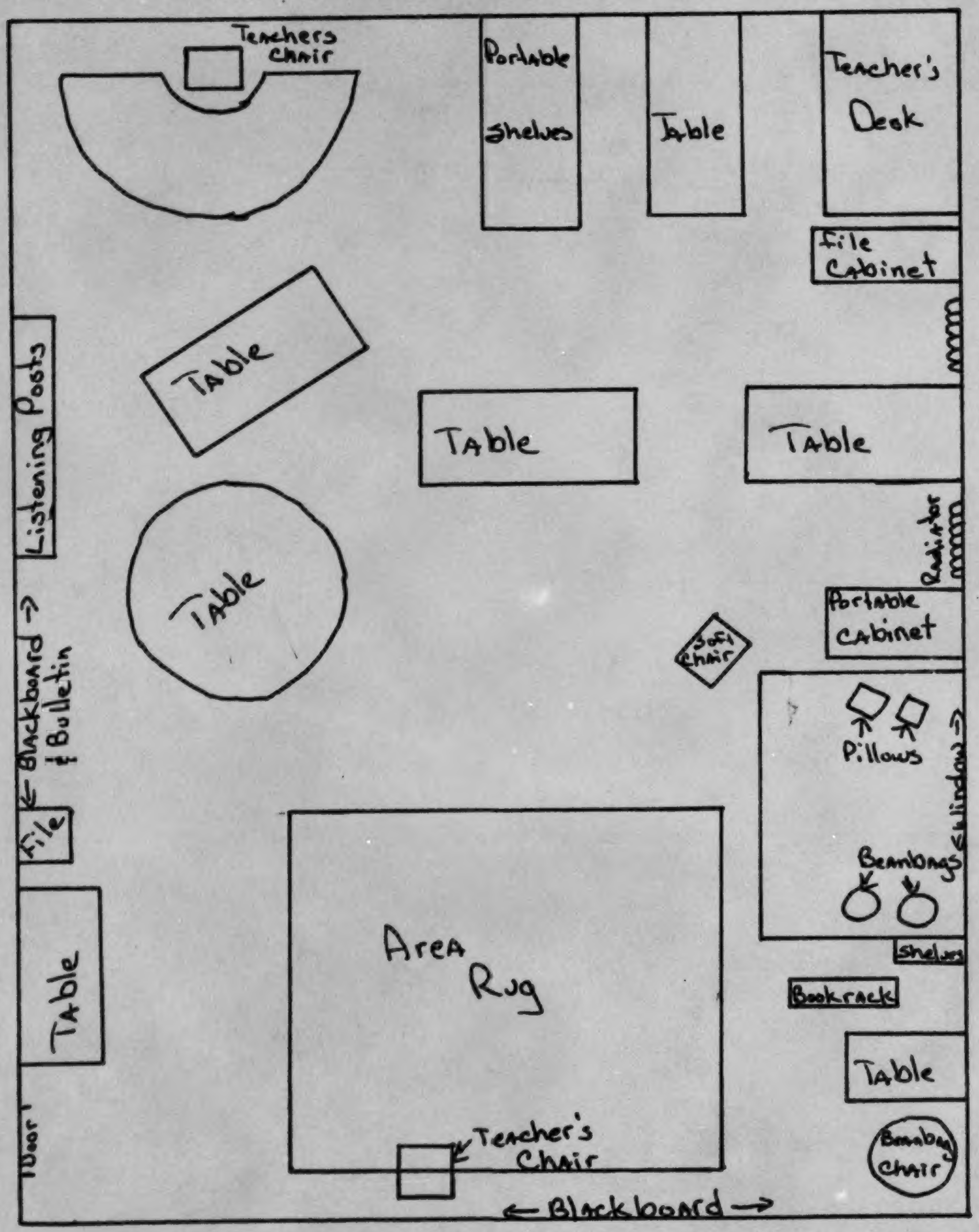
Site B/C

Classroom Diagrams for
Research Site B and C

Classroom Diagram for Research Site B


Closets with doors
Door
Table
Shelves
Table
Table
Closet
Table
(math)
Cabinets
Two
Tables
Braided
Rug
Corkboard
Listening
Table
Table
Chart
Radiators
Bulletin
Puppet
Show Box
Paint
Paint
Teacher's
Chair
Cabinet
Bulletin
Blackboard

Classroom Diagram for Research Site C


Teachers chair
Portable shelves
Table
Teacher's Desk
File cabinet
Listening Posts
Table
Table
Table
Table
Radiator
Portable cabinet
Soft chair
Blackboard & Bulletin
Pillows
Window
File
Beanbags
Table
Area Rug
Shelves
Bookrack
Table
Door
Teacher's Chair
Beanbag chair
Blackboard

APPENDIX B

Site D

Protocol Showing Direct Services of the
Mathematics Project Specialist: Day 4

Protocol Showing Classroom Teacher
Introduce Basic Facts Unit: Day 6

First Observation of Grouping for Mathematics
to Facilitate Mathematics Game Playing: Day 8

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Date 10/28/80
Teacher Code # T
Aides Present 0
Beginning time 10:50
Observer Code # 1
Parents Present 0
Ending time 11:45
Students Present 17
Others Present 1 (Title I Mathematics Project Specialist

Arrived at 10:50 to find the class cleaning up after an art project. Joann, the Title I Mathematics Project Specialist (MPS) was sitting with Ms. T at the semi-circular table. They were discussing various students and groups. In front of them on the table were several stacks of folders, papers, and boxes. Joann explained to me that she planned to work with a series of small groups of children in trying to explain basic facts. Ms. T had requested the "Basic Facts" presentation.

The first four children were identified by Ms. T and told to join Joann on the rug. The four children were: V. (girl), A. (girl), J. E. (boy), J. (boy). (The MPS had a list of the students indicating which group they were in.)

Joann introduced herself as a visiting teacher who had come to their class to show them some fun things to do with math. Joann: "Do you know what 1 + 1 is?" "2", the students call out! Joann commented on how fast they are with the answer. She then presented the group with some dice, asking if they knew what these were. The children said that they have played different games with dice. Joann goes on to explain that we can get different numbers by rolling the dice, and then asks what it is called, when there are 2 of the same numbers on the dice. J.E. faintly suggests "doubles," adding that doubles means getting something extra.

Joann begins to show doubles on the dice, beginning with 2 + 2 and asking the children what 2 + 2 is. The group calles out 4, with A. responding more quickly then the rest. A. likes to give the answer

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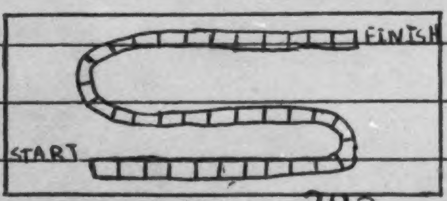
first, so it is hard to tell if the whole group knows the answer, or if they wait for A.'s response and then call out the answer. Joann continues with 4 + 4, 5 + 5, and 6 + 6; in each case the group answers fairly rapidly with correct responses. Joann shows the children that her dice only have the numbers 1-6 on them, but she has made some special dice that have bigger numbers (dice with wooden cubes with numbers 4-9 written on the sides). Joann then arranges the special dice so that the 7 doubles are exposed, asking the students what 7 + 7 is. Silence. Joann shows them how to figure out 7 + 7, by saying that they can start with 7 and count the rest out loud: 7, 8, 9, 10, 11...14. The children call out the numbers with Joann and repeat the number 14 to show that it is the answer. Next, Joann tries 8 + 8. A. calls out 16 immediately, with other 3 children less sure (when the other 3 are asked by Joann to give the answer, they hesitate). So Joann asks them to count out loud again from 8, on. They do so, using their fingers to mark off the last 8 numbers. Joann asks what 9 + 9 is showing two 9's on the dice. This time A. gives them (other children) a chance to respond with all 4 agreeing that 18 is the answer.

Joann stands up, goes over to the blackboard and writes up the doubles already calculated by the students (1 + 1, 2 + 2,...9 + 9).

Joann brings out a board game called "Drag Strip." It is a bright yellow board game with the following design:



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Children exclaim over the board game and say that they like it.

Joann explains the rules of the game: (1) each player first gets a different colored dot, which is his marker, (2) children must roll dice to see who has the most points and thus who will start first. (3) person with the highest number on dice starts first, with the person to his/her left going second, and so forth around the circle, (4) turn = rolling the die, reading off the number, doubling it and calling out the answer. If correct player gets to move one space, if incorrect s/he stays where they are.

Joann complements the group on how quiet and orderly they are and then begins the game. Each child throws the die and calls off his/her number. At the end Joann asks who got the highest number. J. did with a number 9. All group members recognized that J. was first, as they called out his name in reponse to the MPS question. Joann makes sure that children know which direction left is, and then asks them to show which way turns will go. J. rolls die on the first turn, he gets a 4 and does not say anything. Joann reminds the students that all the doubles additions are written on the board and that they may look when they wish. J. looks at the board, and then replies "8." He gets to move one space. A. rolls an "8," and responds quickly with "16"--she also moves one space. V. rolls a 7 and remains silent, even when prompted to look at the board. Finally J. leans over and says "14"--V. repeats "14" to Joann. J.E. rolls a "6," looks at the board, and replies "12." The four students are asked to each take a second turn; in all but A.'s case they refer to the board for their answers.

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Following the second turn Joann looks at her watch and says that she must teach this game to the others. Joann, "Do you think you could play this game again?" ... "Could you teach this game to others?" Yes, they faintly reply.

[Rest of the class has been sitting at the back table, working on a PANTS CHART with Ms. T.]

The first group returns to the back table, and Ms. T sends the second group to Joann. Group members are R. (boy), T. (boy), M. (boy), J.A. (boy), and J.S. (boy).

Joann begins by asking them what 1 + 1 is, "2" they quickly reply, and 2 + 2? "4" is their response. She continues up to 7 + 7, which the boys know (R. leads the answering). Not only do they know what 7 + 7 is but they also answer correctly 9 + 9, and 10 + 10.

Joann introduces her first set of dice by asking if anyone has ever played a game, like "Monopoly" with dice before. Yes, the students reply. Joann then starts her discussion of doubles by asking "Which double is this" (when she has two 5's, or two 1's or two 3's on the dice). The students correctly respond with the number displayed on one of the die--example: "this is a 5 doubles, or a 1 doubles, or a 3 doubles." Joann explains that we can add the 2 doubles numbers. Without showing the second set of dice Joann goes to the board and asks which set of doubles is first, "One," they yell. Joann gets them to identify the doubles and add them; she writes all addition equations on the board from 1 + 1 through 9 + 9. As the numbers get larger, the group is less sure of the sums and take a longer time to respond. R., however calls off answers

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Date 10/28/80　　Observer # 1

quickly. Other students tend to imitate him by repeating his answer. Joann typically accepts the first correct answer given, so when R. responds quickly with the right answer, and the rest of the group echoes him. Joann writes the answer on the board.

Joann brings out the Drag Strip game. Somebody asks if it is a race-car game. Joann explains that in this game, you roll the die and then double it. "If you are correct you move one space, and if you forget what the additions are, where can you look?" The group-replies-, "on the board." Joann says that next time they'll play the game without the additions written on the board. J.S.: "Oh, I get Miss!" Under Joann's instructions (same as before), the children each roll the die to see who goes first. M. gets first turn and rolls a 7. He doesn't know what the double is, even with people telling him to look at the board. T. finally gives him the answer. Joann asks children to keep answers to themselves. J.A. rolls a "6"; J.S. rolls a "4"--both boys refer to the board for the answers. T. rolls a "5" and is able to double it correctly without looking at the board, as does R. with a roll of "4."

The boys are completing their second turn, they are all watching the board game, paying attention to which number each child rolls and frequently offering answers (especially T. and R.). Joann stops game for a minute to explain that each person has a turn, and that the others must not help him. Together they decide that if you give an answer to the player whose turn it is, you will lose a space, or go back one space. This decision primarily reflected the children's ideas about how to handle this problem. Joann listened to their ideas and agreed with them.

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The rest of the class began finishing work; some children have gotten out of their chairs and gone to put away books, pencils, and papers. Their teacher calls them back to the table where they softly sing the "12 days of Halloween."

The small group working with Joann have reached either the 3rd or 4th space (=4th turn, spaces depended on whether they gave out answers to their friends) and are still referring, each time, to the board to see the additions of doubles.

Joann folds up the Drap Strip game and introduces a card game called Zooks! (A few children from the (other side) back table are standing beside the group of children sitting on the rug with Joann.)

(This is the time when Ms. T's class usually lines up for lunch). Joann explains that the Zooks game is a "doubles" game just like the last game. She begins by counting out 5 piles of cards. After she has divided up most of the cards, she hands the rest to T. and asks him to finish putting all the cards into the 5 piles (Joann is playing too!) Joann explains the instructions saying that: "You don't turn the cards over until it is your turn. We keep going around the circle until we see our first doubles (like two 5's, or two 8's). The first person to yell "Zooks" gets to tell the answer and collect all the (turned over) cards." No questions from the boys.

The rest of the class leaves for lunch. Joann and her group are still on the rug and are going through the game once. In having each player expose a card, 2 "Zooks" are found, R. yells out Zooks in each case and gives the correct answer.

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1. Joann thanks the boys, tells them she will leave the games behind
2. and sends them off to lunch.
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TUSD L&R
10/13/80

Narrative Form - Classroom Ethnography D

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Date 11/3/80
Teacher Code # Ms. T
Aides Present Absent
Beginning time 10:45
Observer Code # 1
Parents Present 0
Ending time 11:30
Students Present 12
Others Present

The math period began with the teacher and 9 children sitting on the rug. They were sharing Halloween party stories. The teacher was eliciting the children's experiences. The children were not only talking to the teacher (when they had something to say) but listening to others.

At 10:55 the teacher told the class that they were going to start their math lesson now, but if they did not complete the math assignments before lunch, they would be given extra time after lunch. Ms. T asks her students to sit properly and to look at her while she talks. Ms. T adds that if her students are not looking at her, she is not sure whether or not they are listening.

Ms. T begins the instruction by announcing that today's lesson will be on "Basic Facts." When she asks the group what they think this term means, one boy yells out, "food." Ms. T continues saying that basic facts is just a fancy word for number problems that all of us keep in our head. She repeats this definition, looking around the group to see if all of them were looking at her. The teacher continues her explanation by reminding the students that all of us keep people's names in our heads, and that the students probably already have certain numbers in their minds. Ms. T asks them what 2 + 2 is (they answer 4), and 0 + 0, (0), and 1 + 1 (2). All student responses are given rapidly and in unison. The teacher calls on J (boy), R (boy) and D (boy) to be quiet, because this is a very important talk.

The teacher calls on B (boy) to answer the problem: 3 + 3. R yells out that the answer begins with "s". No answer from B, so the

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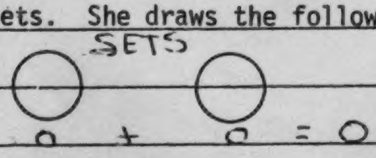
teacher repeats the problem in Spanish. Still no answer from B. The teacher asks the class if they can help him. "Six," they yell out. Turning back to B, Ms. T asks him what 1 + 1 is. He replies in a faint voice: "2."

At 11:00 three older girls enter and take their seats on the rug. The teacher continues her lesson by telling the class that they will go over numbers that they already know and then talk about new numbers. First however, they will start with zeros. The teachers asks the class what the number word for nothing is. "Zero" they reply. Ms. T asks them to spell the word, which they do. The teacher writes a "0" on the board.

Ms. T explains that when we 'add'; we are putting two things together, like sets. She draws the following figure on the board:



"Since there is nothing in these sets, we could say that 0 + 0 = 0," the teacher adds. The teacher asks the children which sign means plus, and which sign means equal. The children respond accurately (and in unison). The teacher then repeated the 0 + 0 equation and turned to B to ask if he understood what they were doing. B did not reply so Ms. T used her hands explaining in Spanish that if she had noting in either hand there would be nothing.

At 11:05 the teacher begins the sequence of " 0 + X" problems, by drawing a single cherry in the second set (or large circle). After telling two children to be quiet, Ms. T asks the children to show

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0 + 1 using their hands. All the children raise their hands, using a fist to show nothing or zero and a single finger to show "1". The teacher leads the children in repeating the problem 0 + 1 = 1. The teacher then erases the cherry and draws another in the first set, making the problem 1 + 0 = 1. When asked whether the problem has been changed by moving the cherry, the children responed with "yes." But they also reply (in responsed to the teacher's question) that the answer has not changed. Ms. T agrees, saying that they have just turned the problem around.

The next problem is 0 + 2, which the teacher illustrates by drawing two cherries in the second set. Before the answer is written on the board, the teacher asks the children to raise hands if they know the correct number. Almost all the children raised their hands with two or three calling out the answer 2. The teacher asks them to show their answer on their hands. They do so, holding them up so the teacher can see them.

(I can hear quite clearly, the words of a movie being shown across the hall.)

Ms. T tells the students that they are going to do all the "0 +" problems up to 10. The children respond with an enthusiastic "Alright!" The teacher continues the problem sequence 0 + 0, 0 + 1, 0 + 2, 0 + 3. . 0 + 10, adding a cherry to the set for each new problem. C (boy) yells out, "lets do some more...how about 100 + 100 = 200?"

All the number problems have been written on the board and are in the proper sequence. Seven minutes after the lesson had been begun the

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teacher looks at the students and asks them what they see or notice from this chart on the board. G (girl) notices that the numbers are in order and that the numbers go from 1-10.

The teacher agrees with G, but points out that each answer has one more than the one before.

Ms. T then tells students that these problems are called "Zero plus one's." She then tells the students that they have taken the first big step in learning basic facts.

All students are told to close their eyes, as the teacher calls off one problem at a time, picking individual children to give the answers. With the first set of problems, Ms. T gives the problems in order (all the answers were correctly given), but mixes up the order, on the second go-round. On the second set, everyone answered correctly except R, who said that 0 + 9 = 10. Ms. T asks R to count out the answer on his fingers.

At 11:19 the students are sent to their respective tables and given the attached worksheets to do. Instructions were as follows: on sheet #1, the numbers 1-10 are written on the bottom and the students are supposed to draw 10 objects (of any kind) in the big circle. On page #2 is the first problem. Two sets are shown, one with 0 objects and the other with 1 object. The children are to write out the problem and answer two times, once beneath the two sets, and again inside the big circle. The square in the lower right-hand corner is for the answer.

(11:24) The teacher tells the class to hand in their sheets as soon as they are finished, so they can get ready for lunch.

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By 11:27, six children are finished. They are told to go sit on the rug. Quiet children will get to go to lunch first. Some of these kids walk from the rug to the equipment cupboard. Ms. T notices R, and tells him to put back the equipment, because he has been playing too much.

By 11:28 all but D are finished. Ms. T hands out the lunch cards and the children line up for lunch. D finishes and goes with class as it leaves room.

Narrative Form - Classroom Ethnography D

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Date 11/6/80
Teacher Code # Ms. T
Aides Present Absent
Beginning time 10:47
Observer Code # 1
Parents Present 0
Ending time 11:30
Students Present 18
Others Present Student Teacher
Principal Investigator

Arrived at the classroom at the normal beginning time for the math period, only to find the 18 children already divided into three groups. Each group was seated at a different table. At table #1, the 6 children were working on their assignments without the help of a teacher or aide. The St. T was working at table #4, while the teacher was explaining the assignment at table #3. (Table #2 was empty.) It was the teacher's original plan to have the groups of children switch tables during the math period, so they could complete all 3 assignments, as each table was working on a different task.

Table #1 (without the teacher) had 3 mimeographed pages to complete. Each page was a different variation of the same theme which was to scan the picture drawn on each page and to color only those sections which had a "0 + __" problem written in it. The completed colorings would then be a "hidded picture." The 6 children were interested in their project and were working on coloring the correct sections. (Thanksgiving decorations are up in the room.) There was some talking between children as they colored (using small boxes of crayons) but the noise level was low. (I walked around the table to see if any children were having problems identifying the correct type of equations to color. (I saw no incorrect responses.) Not all children were working at the same speed. Most children were just finishing page 1, while M was already on page 3.

At table #4, the St. T was leading 6 more children in a card game using buttons on strings. The goal of the game was to wait until a card showing a "0 + __" addition was turned over, and to yank the string and button away before the St. T could capture the button with his cup.

TUSD L&R
10/13/80

Narrative Form - Classroom Ethnography

Page 2 of 5

Date 11/6/80 Observer # 1

(This is a game that was introduced by the Title I Math Project Specialists at the inservice.)

The St. T worked (on this particular game) with the children, for only a few minutes, switching after that to Zooks, another card game, and a variation of the "0 + __" problems. The St. T explains the instructions to the students. The St. T will turn over the cards one by one and each time the children see a card with a "0 +   " problem they are to yell out Zooks. The first child to yell Zooks will get the chance to give the correct answer to the addition. If s/he can solve the problem correctly s/he will receive all the cards turned over. The first problem revealed is "4 + 0 =". The children were not sure of the correct answer. (Not all problems were "0 +   ", as half the problems were reversed: "   + 0".) The St. T talks in Spanish to the children as they get louder and louder--yelling out Zooks. They enjoy yelling out Zooks every time a card is turned over, without waiting to see if the problem is the correct type or not. St. T tells the children to pay attention to the game. Children are becoming more restless.

At table #3, the teacher has asked all 6 students to fold their papers in half. On the first half of the paper, the teacher asks the students first to listen to the problem she calls out and second to write out the problem--without the answer. These first problems included: 0 + 8, 0 + 10, 0 + 4, 0 + 6, 0 + 5. All students are orderly--listening first to the instructions and then to the problems called out. After they finish these, they are told to turn over their papers, No. 1-11, and to listen once again to the problems the teacher calls out. Only this time, the

Narrative Form - Classroom Ethnography

Date 11/6/80 Observer # 1

students are instructed to write only the answers. As the teacher works with this group we can hear the children (at table #4) calling out Zooks. The teacher notices some of her children looking over at the game table and tells them that everyone will get a chance to play.

By 11:00 am, or 13 minutes later, the children are told to switch tables, with the Table 3 children moving to Table 1, the Table 1 children going to the game table (#4), and the Table 4 children moving over to work with the teacher.

As the children from Table 3 go to Table 1 and sit down to their coloring tasks, they are not sure whether they must answer the problems before coloring the sections. The teacher walks over to Table 1 and points to the blackboard where the instructions are written. They are not supposed to write out the answers, only to identify and color the appropriate sections.

While the teacher is explaining the coloring instructions to Table 1 the children (who are waiting for the teacher to return) at Table 3, pretend that they are still playing Zooks. All children put their pencils in the middle of the table, with children taking turns calling out Zooks and slamming his/her hand on the table before the others can withdraw their pencils. There is laughter and smiling as they play. (11:05) The teacher returns, hands out pieces of paper and gives the following instructions: 1) "listen carefully--to how noisy the other tables are", 2) "put your names at the top of the paper and divide it in half." The children comply by folding the paper in half--but some worry that their folds aren't straight. The teacher tells them not to worry and to go

Narrative Form - Classroom Ethnography

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Date 11/6/80 Observer # 1

ahead and write out the numbers 1-11 on both sides of the paper. The children call out (softly) the numbers as they write them down. One girl writes her numbers like this: . The teacher notices this and tells her that she must redo the numbering so it looks like her's: . This takes a minute. Once the correction has been made, the teacher tells them to keep their papers covered while they write out the answers to the problems she will call out. The teacher repeats her instructions in Spanish.

At Table 4, the St. T is leading the group in the button game. The St. T flips over the cards, one by one, when a "0 + __" problem appears the students try to pull out their string begore the St. T can pounce on them. The children are laughing and giggling as they wait for the cards to be turned over.

At Table 3, the teacher has had to start over again because some children did not understand that they didn't need to write out the problems. She begins again with 0 + 0, ..., 0 + 2, 0 + 3, 0 + 4. P (boy) works the first three problems, but is distracted on problem #4, doesn't listen as the teacher calls out the problem and is startled when the teacher says problem #5. P looks around and notices V (girl) has her elbow on his paper. He tells the teacher who instructs V to keep her hands to herself.

(11:18) At Table 1, the children on coloring page 2 and 3. Two girls are coloring their pictures very neatly by outlining each section before coloring it in. D is counting 8 + 8 on his fingers; he is writing out the answers to all the problems and then coloring the 0 problems.

Narrative Form - Classroom Ethnography

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Date 11/6/80 Observer # 1

M notices this and tells D that he doesn't need to write out the answers. They disagree, so D gets up, walks over to Table 1 and asks the teacher what to do. (Teachers tells D that there is no need to write out the answers.)

At 11:23 the children at Table 3 are straightening their desks and moving over to the rug to get ready for lunch. Table 1 is following suit by stacking up the colored pictures (all children have finished coloring). E (girl) from Table 1 is told to clean up the table.

In two minutes all children are sitting on the rug and are told by the teacher that only quiet people will get to take out equipment. The teacher asks her class who is the quietest. All students raise their hands. The question is repeated with the teacher adding another question "What should we do about the equipment?' The children explain that they need to finish their kickball game so they are allowed to take out the one ball.

11:30 Class goes to lunch with the teacher. St. T goes home for lunch.

Note: Only 2 table switches were completed.

APPENDIX C

Site E

Mathematics Inservice on
Fractions and Decimals

Students Playing Fractional Cover Up

First Day of MPS Direct
Services in the Classroom

Thursday, January 22, 1981
8:30 a.m. - 11:15 p.m.

Teacher
Observer 3
Students-22

8:30 I greeted K, P and O at 8:30. I took a desk away from the teachers as tables were filling quickly. Twenty-two were present; I recognized two aides, plus three Resource Teachers and two observers. Three of the twenty-two participants were male.

X began the workshop by handing out a pre-test. She said, "many children prior to fifth grade have not come across fractions." She went over the pre-test.

Several raised questions over number 17. X took twenty minutes to explain that a number can be divided by any number except zero.

9:00 Envelopes containing blue, red, and yellow strips are handed out. We divide three of the yellow strips into halves, fourths and eights.

9:07 The red strips are divided into thirds and sixths.

Most people had difficulty dividing the blue strips into fifths and tenths.

9:19 X asks for some sentences about fractions using the strips. An example: $1/4 > 1/5$.

9:21 All play a game called "Roll and Remove." A die is marked: 1/4, 1/2, 1/8 and 1/16. The game board (given to each player) is one large square. Each player covers his/her board with either 1/2's, 1/4's, 1/8's or 1/16's. Each player takes a turn to roll the die and remove the piece as designated by the die. If unable to remove a certain piece, the player must trade. The first player to remove all pieces from his/her game board wins.

9:30 The game ends.

9:32 A new game begins using a graph sheet and cuisenairey rods.
1 orange rod 1
2 yellow=1 orange 1/2's
5 red=2 yellow=1 orange 1/5's
10 white=5 red=2 yellow=1 orange 1/10's.
X suggests teachers have their students write out math problems:

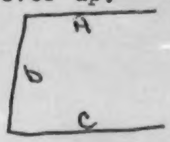
 1 fifth
+2 fifths
 3 fifths.

9:40 - 9:50 O introduced the game "One." Teachers play to test it out. A deck of cards are marked 1/3, 1/8, etc. Seven cards are dealt to each player. The object is to get "one's." For example: 1/3 + 2/3 = 1, 1/8 + 2/8 + 2/8 + 3/8 = 1.

9:53 Game ends and X goes back to cuisenary rods and graph paper.

10:00 The lesson on rods ends.

10:01 A new game using the rods is played. Each player gets a sheet labeled, "Fraction cover up."



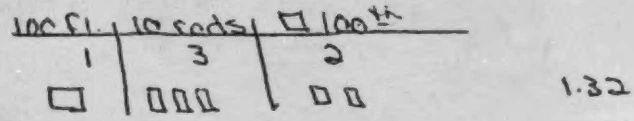
The object of the game is to fill in squares a, b and c with 1/10, 1/2, 1/5 or whole rods. The addition is recorded at the bottom of the sheet.

10:10- 10:30 Coffee break. I talk with one teacher about my job. Another EA and I discuss observations.

10:30 P and O go over three games teachers will receive: "card sorting, " "war with fractions" and "Fraction concentration."

10:32 X introduces "Decimal spin." I observe the teachers playing the game. Individuals must have one 100 square flat. They roll dice for 1/100's & 1/10's. First player to fill the flat wins.

10:45 Game ends. X asks each individual to have two 100 sq. flats, ten 10's, one 1/100, and a place value sheet.



Her first example is one and thirty two hundreths. X. illustrates again.

10:59 X gives an overhead explanation for rods and decimals.

$$\begin{tikzcd}
\text{visual image} \arrow[rr, leftrightarrow] \arrow[dr, leftrightarrow] & & \text{verbal name} \arrow[dl, leftrightarrow] \\
& \text{abstract symbol.} &
\end{tikzcd}$$

11:00 X briefly goes over the last handout "Write the numeral."

11:02 P briefly goes over a game similar to spoons, " grudge." Each player needs three cards: picture, words and number, to equal a decimal. First person to have three cards representing a decimal (ie. 1.43) grabs a grudge. The loser puts down a letter of the word. First person to spell "grudge" loses.

11:05 Teachers play game.

11:15 P calls a stop to the game. She tells teachers what is in the bags for them. She also says they have items to sell.

The workshop ends at 11:20.

I found this workshop to be more active as far as participation by the teachers.

Ms. W and I decided I should be at her classroom at 9:00 a.m. Monday.

10:04 She tells the students to take their purple strips out. Hers are red. The first piece is to be laid aside as a whole piece. The second is folded into thirds. (She demonstrates) It is to be marked with "1/3"'s. The third piece is folded into thirds then folded into half for sixths. They are to mark each section "1/6."

10:06 Briggs leaves for the restroom. Ms. W tells the students to lay out the pieces for one whole, one third and one sixth.

10:07 The principal enters and asks for Mrs. S to follow him out.

Ms. W asks for fractional sentences. Example: Carlos says, "1/3 = 1/4."

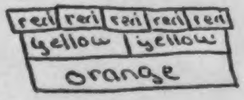
10:08 Ms. S returns. Ms. W questions Carlos. Briggs wants to give a fractional sentence, but Ms. W tells him to put his hand down, knowing he knows, but she wants to give others chances.

10:11 Ms. W asks the students if they want to play a new fractional game. Most say no. They are told to put their materials away.

10:12 Michael and Troy leave for the restroom. Students are told to be seated at their desks.

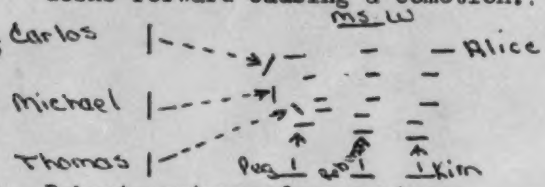
10:13 Ms. W hands out sheets for the game "Fractional Cover-up." She explains the game while seated on a rectangular table up front. Materials are placed on Alice's desk.

Ms. W holds up a green die. She reads "red, yellow, white and orange. These refer to the color of the rods. (She holds up an orange rod) How many yellows make an orange? ("two.") How many reds? ("five.") (She's stacking the rods on top of each other.)



How many whites? ("ten.") What do you know about two whites and one red? ("2 whites equal 1 red") Think of combinations when playing this game." She holds up the game sheet and demonstrates how to fill it up.

10:22 Interruption. Many students in the back west corner move their desks forward causing a comotion..



10:23 Roberto returns from restroom, and is questioned for being late.

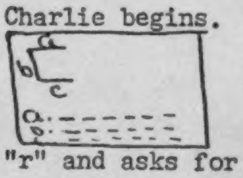
Ms. W tells the class to leave the addition at the bottom of the sheet for tomorrow.

10:24 Shawn leaves for the restroom. The students return to their same group positions.

10:25 Ms. W explains what to do if a person runs out of a certain rod - trade: two whites for a red, two yellows for an orange, etc. Shawn returns.

I'm at Kim's group first. She's the scorekeeper and Pam is the banker.

Charlie begins. He rolls an orange. He covers line "a." He rolls again and gets another orange. He covers line "b." On his third roll he gets "r" and asks for "1/5."



Ms. S is standing near by. She tells the group to roll only once, ask for the fraction and then pass the die. Charlie puts one orange and his red rod back. The game proceeds.

10:30 I'm at Alice's group; she's the banker. Due to enthusiasm and perhaps competition, this is the loudest group. Linda motions for rods, she does not speak.

Ms. S is at this group also. She notices the members are asking for rods by color. She asks the group what each rod represents as a fraction, and tells them to ask for rods by fractions.

10:34 Ms. W joins this group. She notices the bank's low on reds and explains how to trade.

10:35 I move to Tim's group. Michael is the banker. I notice how cooperative and quiet Michael is not. He'd rather tease and throw rods than play the game. (I was told later he's near expellsion.)

At this group most are calling the fraction after rolling the die. Still some question others for proof to the die roll and where a rod was placed.

10:39 Charlie is the winner and the game ends.

Carlos's and Alice's group are still playing for a last winner.

10:41 Thomas leaves for the restroom. A boy enters and hands Ms. W meal tickets.

10:42 All the games end.

10:43 Thomas returns. Ms. W settles the class. She asks that the desks be straightened and there be total silence.

10:44 Ms. S leaves.

10:45 Ms. W asks the students to look at their sheet and to think of what they learned.

She first calls on Brenda. "Ten 1/10's equals a whole." After a few more, Ms. W tells the class to work silently, and she walks back to talk with me until 11:30.

Aside from what I've put in parentheses, Ms. W and I talked first

Tuesday, February 3, 1981
9:05 a.m. - 10:30 a.m.

Teacher E
Observer 3
Students-25

Overview

Class begins with an introduction by P. and an overview as to the weeks activities. Next, P. takes a group to the back to work with pattern blocks. Ms. W has the rest of the class working on fractional number lines on page 189 of Mathematics Around Us.

After showing the block representation for 1/1, 1/2, 1/3 and 1/6, has P.'s first group play "Activity 2. and 3." This is followed by the game "1" or "I Can't Believe I Did the Whole Thing."

Her second group plays "Pattern Block Cover Up" while Ms. W's group is going over page 189.

The lesson period ends with both P. and Ms. W trying to explain fractional number lines to the students.

9:05 Ms. W introduces P. (The MPS) to the class, who in turn introduces her activities for the next few days. She mentions playing the card game "One."

9:07 The MPS calls Will, Thomas*, Katherine*, Don *, Jake and Roberto* to join her at the back rectangular table. I am sitting at the rectangular table adjacent to the group.

P. spills out several pattern blocks. She asks each student to pick up 1 yellow hexagon. Next, she asks them to find two blocks that will cover the hexagon - two red trapezoids. Third, she asks that they find three blocks of the same size to cover the red blocks. The students pick out blue diamonds. Finally she ask them to look for six blocks to cover the blue ones - six green triangles.

P. Checks to see that each student completed each step, then asks that they clear the "board" to begin different puzzles.

She hands them each "Activity 2." She goes through the directions for #1.

With each student holding two blue diamonds, she asks "Can you do..." as they demonstrate.

P.: Can you do a?
Sts: yes
P.: Can you do b?
Sts: no
P.: Can you do c?
Sts: no
P.: Can you do d?
Sts: yes

P. follows the exercise by saying, "Two blues equal 1 whole. What is 1 of 2 equal pieces?" Jake says: "1/2."

P. asks the students to clear their boards. She asks which blocks represent a half. First, she puts down a yellow hexagon. One red block represents 1/2 of the hexagon.

P. asks how that could be proved. Thomas says, "Use two red to cover the yellow."

P. agrees. She then asks for blocks representing 1/2 of the red. The students say there are none.

P. asks for two blocks to fit the blue rhombus or diamond. The students pick up two green triangles. P. repeats that 1 green triangle is 1/2, or 1 of 2 pieces the same size.

She asks if there is a half of the green triangle. The students say "No."

9:17 The handout is returned, and new ones are issued; "Activity 3."

For problem number 1, some are not as apt to changing pieces around to fit inside the design. Don is first to finish and quickly.

For number 2., four blues fill the diamond. P. takes away one piece at a time and says, "1/4, 2/4's, 3/4's, 4/4's, or 1 whole."

With problem number 3, the students are stumped by three blues covering the hexagon; what 1 of 3 is called. P. writes the denominator on the board- /3.

she puts the numerator above it- 1/3, and asks for the fraction. The students respond "1/3."

She writes fractions **for the** number of 1 green or 1/6, and the number of 1 yellow or 1/1.

9:24 She asks the students to clear the board for the card game: "1 or I Can't Believe I Did the Whole Thing!" (This game was taught two weeks ago at the workshop; refer to handout.)

P. goes through the directions: each player will receive seven cards; the object is to make 1 whole. For example, 2/6 + 2/6 + 2/6 = 1 whole.

Thomas shuffles the cards and deals seven to each player.

Will turns away from the table to sort his cards in his lap.

P. tells the students to fix their cards so all 1/2's, 1/6's and 1/3's are together.

Jake is first to start. P. helps him put 1/3 + 1/3+ 1/3 down to make 1 whole, and then tells him to draw.

Next, P. helps Will with 1/3 + 2/3's. Will has difficulty comprehending discarding.

Next, P. helps Roberto* **who has** several "wholes," but is not putting them down. P. writes the combinations on the board to illustrate and clarify the objective; 4/6 + 2/6; 1/3 + 2/3. Roberto puts down his "wholes" and discards.

P. helps Katherine*. **A 2/3's is** on the discard pile. She has a 1/3 and 2/6 card in her hand. P. asks Katherine if she wants the 2/3's card or to draw. Katherine chooses the 2/3's card, but places it with her 2/6's card.

Next is Don. He too has trouble with 1/2 + 1/2 being a whole.

9:36 The game ends just as Thomas is getting the hang of it.

From 9:36 to 9:45, I've been looking at the art work the children have done for a bulletin board (by the sink) for rodeo weekend. Ms. S is putting up the art work.

Briggs' picture is a Devil stomper with "666" written below him. Ms. W and I ask Briggs what the "666" represents, and he says, "The Devil's birthday." We ask if he attends church and studies the Bible and he says yes to both.

9:45 Ms. W is going over a math handout she had asked the class to do earlier. The students are also referring to page 189 from Mathematics Around Us.

As they are getting organized, I notice another new bulletin board (west wall), on the month of February. All the dates are in either pink or white hearts, (♡)

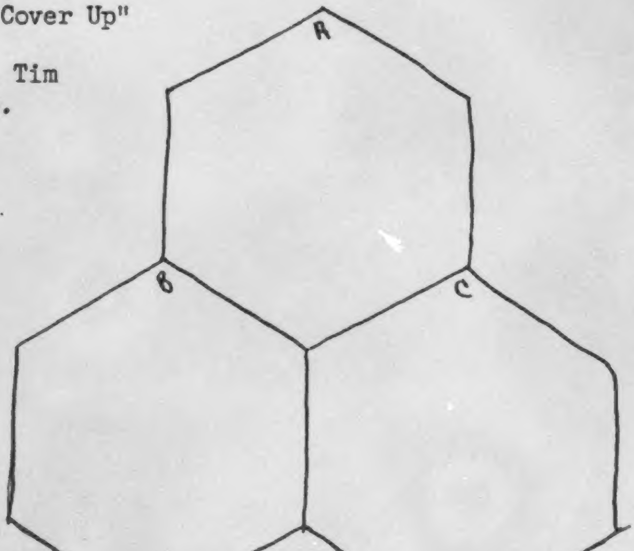
written with red magic marker. The background is black contruction paper.

9:56 I hear P. introducing a new game:

"Pattern Block Cover Up"

Troy, James, Steve, Gerald, Tim and Danny are in this group.

P. hands each student a game board:



Addition is at the bottom of the sheet.

The die is marked 1/1, 1/3, 1/2 and 1/6. A player rolls the die, calls out the fraction, picks up a block representing that fraction, and places it in either hexagon a, b or c. First one to cover the three wins.

Steve is first to roll. 1/6; he puts a green triangle in a hexagon.

Each player calls out his roll and takes the block representing the fraction from the bank.

The game stops momentarily, so Steve can trade 1/6 + 1/6 + 2/6 + 1/3 for a whole.

10:03 Troy wins the game. Gerald wants to play again, but P. says she must stop.

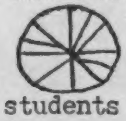
M. W has all the students up front clustered around her. She has a problem for P., it's about numerators, and demcnimators.

On the board is written: 2/3 = 4/6 = 8/12 = 12/18 = 16/24.

The students want to know why 6/9 does not come after 4/6, instead of 8/12's. (Not all students want to know; Jake, Troy Roberto*, **Danny***, **Charlie**, **Kim** and Thomas* **aren't paying attention.**)

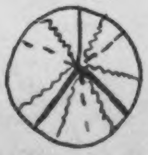
P. says she'll demonstrate equivalencies with the blocks she used earlier:
1 yellow hexagon
2 blue diamonds 1/3's
4 green triangles 1/6's.

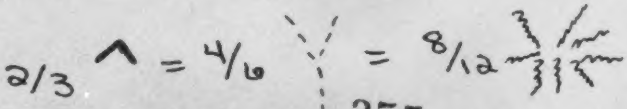
She then draws twelfths on the board:



(hers was equally divided)

But students still look puzzled. So she erases and draws:

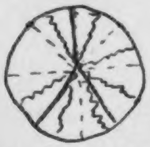




And says, "Use the same amount of pieces to share with 2/3's." She mentions that lots of fractions could have worked, but this author (page 189, *Mathematics Around Us*) chose this pattern.

10:18 Julie asks how to go from 6/9's to 12/18's.

P. draws:



2/3 = 6/9

Each one into 1/3's again.

2/3 = 6/9 Six of nine is another name for two of three.

P. asks if it can be divided into 1/3's again for 1/18's? No, Julie says; "try 1/2"
12/18 = 6/9 = 2/3!

Pete asks why 2/3 = 4/6 = 8/12 = 12/18 is not 2/3 = 6/9 = 12/18.

P. says, "You decide whether to cut by 1/2's, 1/3's etc."

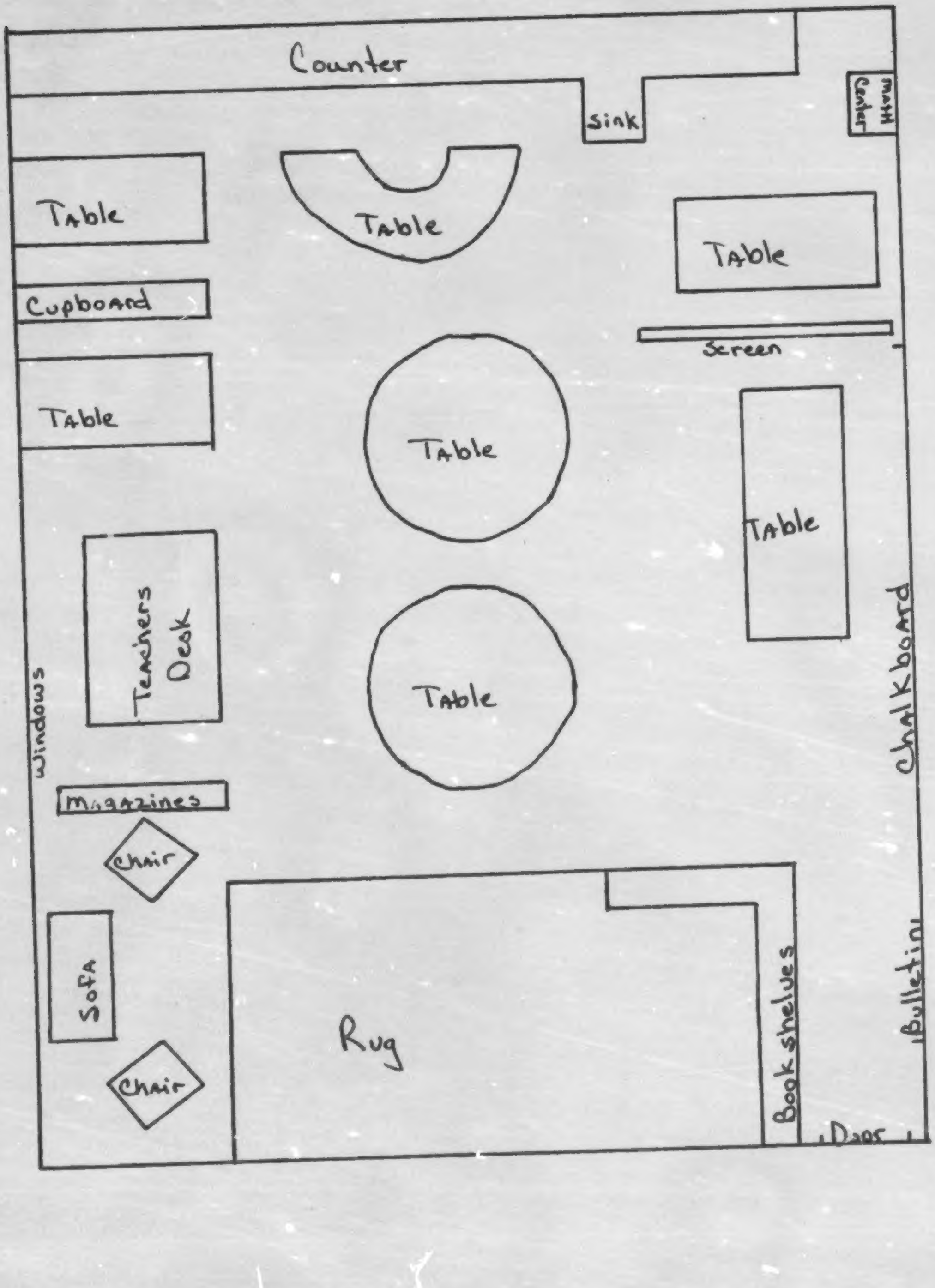
10:24 P. and Ms. W think a workshop for the children by X. on number lines is needed. Also, I suggest to P. to diagram the blocks on the playing cards "1" to help clarification/identification.

10:30 P. and I leave.

APPENDIX D

Site F

Classroom Diagram for Research Site F


Counter
Sink
Math Center
Table
Table
Table
Cupboard
Screen
Table
Table
Table
Teachers Desk
Table
Windows
Chalkboard
Magazines
Chair
Sofa
Rug
Bookshelves
Bulletin
Chair
Door

APPENDIX E

Site G

Direct Services of the
Mathematics Project Specialist, 3/16/81

Title I Aide Using Manipulative
Aides to Teach Fractions

Narrative Form - Classroom Ethnography

Page A of ____

Date 3/16/81 Observer # 3

Overview

First, students were observed taking a multiplication and division test.

After completing the test, Ms. W. called a group of target students together.

The students and Ms. W. went through a series of exercises using pattern blocks. The objective was to denote "whole, one half, one third, one fourth and one sixth."

After the exercises, the group played "Pattern Block Cover-Up."

Those not with Ms. W. were at their desks completing other assignments.

Narrative Form - Classroom Ethnography

Page 1 of 7

Date 3/16/81 (Monday)
Teacher Code # G
Aides Present 1
Beginning time 10:00
Observer Code # 3
Parents Present 0
Ending time 11:30
Students Present 25
Others Present 1

At 9:55 a.m. sixteen students were present. The students were at their desks finishing up an earlier assignment. Ther math test is at 10:00 a.m. Most were working on spelling, writing each sentence on the board three times.

Ms. L. was at the rectangular table, cutting out numbers and pasting them on a construction paper board. Violet was seated with her.

10:00 Ms. R. asked the students to put everything away and to return to their desks. Ms. R. handed out test papers.

A student asked if they could start. Ms. R. said, "yes." No directions were given. The test was from Mathematics Around Us (refer).

Katie* used a cover sheet and had drawn a graph strip on her desk. She spent most of her time looking around. Her face expressed discouragement.

10:10 Tammy handed her test to Ms. R.

10:12 Ms. W. arrived.

More students were handing in their tests. A few overlooked problem seventeen.

Ms. R. handed me a fun sheet that students were also completing today because of St. Patrick's Day (refer).

Ms. R. said several were at Reading still, but five were absent today probably with the flu.

In several areas of the room were decorations commerating St. Patrick's Day. In fact, assignment five for today said "shamrock table."

10:23 Seven students returned from Reading.

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10:24 Ms. W.'s first group included Carrie*, Grace, Katherine, Katie*, Maria, Sheryl and Ms. L.

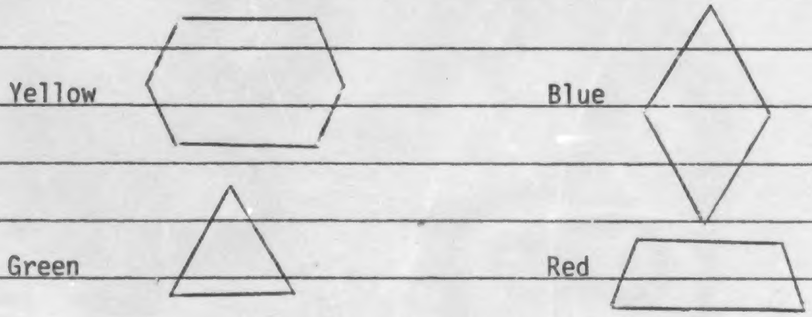
Ms. W.: We'll be working with pattern blocks.

She passed out a pink sheet.

W.: We'll call this a work space.

She opened a small box and picked up a red pattern block. Next she picked up a yellow, blue, and green pattern block.

W.: I'll pass out the yellow, each of you take four.



Ms. L. was grading papers as she tried to listen to Ms. W.

W.: Take one yellow block and put it on the work space by itself. Find two blocks of the same color that you can put on top of the yellow block and be the same shape.

Sheryl found the answer first. Soon a pattern of copying began.

W.: Two red cover the one yellow. Two reds to make one yellow. One block might be called what?

Gr.: One half

W.: One of two pieces. Call it one half. Say "one half."

Sts.: One half.

W.: Look at another yellow. Find three blocks of the same

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color that will cover the yellow.

All reached for three blue diamonds. Katie* was one of the first to finish.

W.: You are good listerners and doers. What color?

Sts.: Blue.

W.: How many?

Sts.: Three.

W.: Three blue blocks to cover one yellow. Takes two red to cover one yellow. One of two parts is one half. How many blue?

Sts.: Three

W.: This is. . .

K*: One half.

W.: One of three, or called. . .

M.: One fourth, one half. . .

W.: One of three, or one third.

She reviewed one of two is 1/2 and one of three is 1/3.

W.: Take another yellow. Cover it with one block.

All chose a yellow hexagon.

W.: What color?

Sts.: Yellow.

W.: I can't trick you. Call this one of one or one whole.

She passed out one more yellow to each.

W.: Cover this yellow with six blocks.

Katie* watched to see what others chose and then covered hers with

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six green triangles.
W.: What color?
Sts.: Green.
W.: How many?
Sts.: Six.
Grace: Because there are six sides.
W.: Do you agree that there are six sides?
Sts.: Yes
W.: It's called a hexagon. Put blue on top of the green.
What are we doing next Grace?
Grace: Putting red on top of the blue.
Ms. W. reviewed halves, thirds and sixths.
W.: How many reds? One of two. Each is called one half.
What do we call this one green piece?
M.: One half.
K*: One and one half.
C*: One sixth.
W.: Say it again.
C*: One sixth.
W.: Take one yellow and cover this yellow block with four
peices of any color.
Katie* had one red and three green. Grace had two blue and two green.
W.: Double check and see if you have four on top of the yellow.
Look at Sheryl's: two blues and two greens. Anyone else?
Katie*, Maria and Katherine had one red and three green.

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W.: This time use five blocks.
M.: Different colors?
W.: Yes.
W.: Double check to have how many?
Sts.: Five.
Sheryl: I think everyone has the same.
W.: Why?
Sh.: You can only use two shapes.
W.: Ok. Count to see if you have five. Did everyone use blue?
Sts.: Yes.
W.: How many?
Sts.: One.
W.: Did you use green?
Sts.: Yes.
W.: How many?
Sts.: Four.
W.: Sheryl, tell us what you said.
Sh.: With these you can't use any other blocks.
W.: Ok, put all your blocks in the center. Now we have an activity "Pattern Block Cover Up."
She passed out the game boards.
W.: See if you can cover up the pattern.
M.: Different colors?
W.: No, just yellow. How many?
Sts.: Three.

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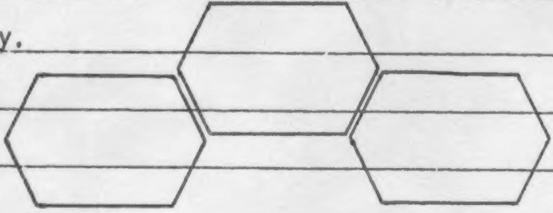
W.: Now this is how to play. . .on the die, "r" stands for. . .

Sts.: Red.

W.: "g" for. . . If you roll a "r" you put one red on one of the shapes. Once you put a piece down, you can't change your mind. You can use different colors. First one to cover up all three is the winner. Any questions? Do you all understand?

Sts.: Yes.

The game progressed quickly.



Gr.: I rolled a green.

W.: Do you take more or less greens to cover a place?

Gr.: More.

Students soon learned it was best to get yellows than greens. And they could easily determine the placement of assorted pieces.

Katie* won first, Carrie* second, Sheryl third, Grace fourth, Katherine fifth and Maria last.

W.: Katie*, tell me the colors used in one of your shapes.

K*: Two blue and two green equal one whole.

She wrote "2b + 2g = 1y."

She wrote an example from each girl.

11:05 W.: Put the blocks in the center of the table. Hand me your

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boards. Leave the pink sheets on the table. You can quietly go back to your seats.

Ms. L. rounded up the next group: Juan*, Rene, Al*, Paul, John and Mill.

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Date 3/23/81 (Monday)
Teacher Code # G
Aides Present 1
Beginning time 10:20
Observer Code # 3
Parents Present
Ending time 11:40
Students Present
Others Present

10:20 - 10:35. Mrs. R. and I discussed last week's, this week's and next week's agenda.

Monday, Tuesday and Wednesday Ms. W. conducted fraction workshops for the same twelve students included. I had observed Monday and Tuesday.

Today the students were to complete a handout on division by eight. After lunch they would go to the chalkboard by rows to write the the division and multiplication problems. Also, Ms. L. would conduct a workshop on making fraction packs at the rectangular table.

Tomorrow, the class would play "Yatzee" while the workshop on fractions continued.

Thursday, Ms. W. will be in to give those who were not included in last week's workshop a chance to play games, etc. They were the high achievers and had complained to Ms. R. that they wanted to be with Ms. W. also. Thursday afternoon Ms. R. would give a fractions test to the entire class.

The following week, Ms. R. would give a multiplication and division test to the two thirds who failed the test the first time.

The exercise Ms. L. was going through with the students today was given by the resource teachers last fall.

L.: Ok, you get one little hard square. Let's cut it and find out if it's 1/16's. (later) Has everybody counted?
Sts.: Yes.
L.: Do you have 16?
Sts.: Yes.

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L.: Ok, this is 1 out of 16, so I want you to write. . .

Sts.: 1/16.

L.: I want you to put all your pieces in an envelope to keep to play a game. What if you lose pieces?

Sts.: You can't play.

L.: Right.

(Students wrote "1/16" on each brown square.)

L.: Show me 1 out of the 16 pieces. What is 1 out of 16 called?

Carla: 1/16.

L.: Show me 2/16's; 2 of your 16 pieces.

10:45 Ms. L. had the top achievers: Eileen, Steve, Tammy, Diane, Carla, and Julie.

First, Ms. L. had the students cut:

1 whole (green)
2 halves (white)
4 fourths (red)
8 eighths (purple)

out of construction paper.

Ms. L. handed out a brown sheet.

L.: Cut to make 1 whole.

(Students used the green paper as a model.)

L.: Now fold it in half.

Tammy: It's going to be 1/16's!

L.: How do you know?

Tammy: Because last time we folded into 1/8's and half again will

Narrative Form - Classroom Ethnography

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Date 3/23/81 Observer # 3

be sixteenths.

L.: Fold it in eighths. Now what do I want you to do?

Sts.: Fold it in half.

L.: Does it equal something else you've cut?

Steve: Yes, 1/8.

L.: Show me four sixteenths. Look like something else?

Carla: One fourth.

Steve: Two eighths.

L.: Show me eight of the 16 pieces.

Steve: Two of the red squares.

L.: Or. . .?

Julie: One of the halves.

L.: Or four of the eighths. Show me eleven of your 16 pieces.

(Tammy had written 11/16 for 1/16 by mistake and the others did not believe 11/16's existed.)

Steve: It can equal 1 of our whites.

(Julie had 2 red, 1 1/8 and 1 1/16.)

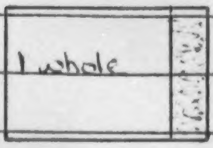
L.: See (pointing to Julie's) you can make 11/16's. Ok, here's your white envelopes. Write your name on it and put your pieces inside.

The envelopes are being kept to play "Roll and Remove."

11:05. The slower group went up to play: Juan*, Pete and Carrie*.

Ms. L. asked if they had a black crayon; they did.

L.: Cut your green paper to this size:



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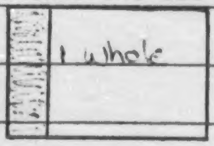
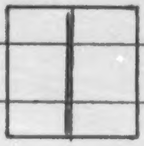
Date 3/23/81 Observer # 3

(She had given them a model.) Next, Ms. L. handed out white paper.

L.: Hold your paper like this and cut off this side:



L.: Put your green down and hold on to your white. Now fold your white in half. (She folded Carrie*'s to demonstrate). Now open it and cut it down here.



It's going to make two halves. What do you have Pete?

P.: Two halves.

L.: What is one?

P.: One half.

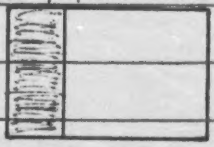
L.: Ok, label your pieces.

Juan* looked at what Ms. L. was holding up to copy writing "1/2."

L.: How many of this (white piece) go on your green paper to show me one half?

P.: One.

L.: Now I'll give you a red paper. Use your green and cut:



L.: Now get the red square and fold it in half.

P.: Cut it again?

L.: Not yet. Save the scraps. Fold it one more time. How many will you have?

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Date 3/23/81 Observer # 3

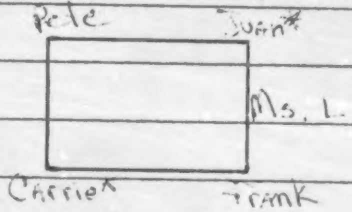
J*: 4.

C*: 4.

P.: 8.

L.: Cut it and find out.

11:15. Frank walked in and Ms. L. told him to join the group.



L.: How many pieces?

Sts.: 4.

L.: What is 1 of 4?

P.: One fourth.

L.: How do you write it?

Pete wrote "1/4" without waiting for assistance.

L.: Now show me on your green sheet one of four pieces. Now show me two of four pieces. It equals what?

P.: One half.

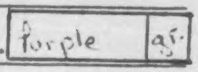
L.: Show me.

Pete put a half piece over two fourths.

L.: Put all your pieces under the green sheet.

(She handed out a purple sheet.)

L.: Put your green sheet under the purple and cut.



F.: Fold it (the purple sheet)? (he does anyway)

L.: Fold it in half. Fold it in fourths. Now what do I want you to do?

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Date 3/23/81 Observer # 3

P.: Fold it in half and get 8.

L.: Why 8?

P.: I don't know. . .well. . .four two's are eight.

L.: Ok, fold and cut and see if you get 8.

P.: I know what this is called.

L.: What?

P.: One eighth.

L.: Why?

P.: There are eight pieces. This is one out of eight.

L.: Boy Pete, you are smart! On your green paper, show me one of eight. It's called what?

P.: One eighth.

L.: Show me two of eight. Equal something?

P.: One half.

L.: Show me.

Fr.: It equals 1/4.

L.: Show me. Ok, now show me four of your eighths.

Fr.: It equals a white.

J*: One half.

L.: I have one more sheet.

P.: It's going to be brown.

Ms. L. handed each a brown sheet. The students cut it from their model, and fold it into half, fourths and eighths.

J*: Do you want fifths?

L.: Fold it again.

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Date 3/23/81 Observer # 3

P.: Sixteenths!

L.: One of sixteen would be called?

(Carrie* was still cutting.)

P.: One sixteenth.

L.: One sixteenth?

P.: I don't know.

L.: You're right.

Ms. L. handed Pete an envelope.

L.: Write your name on it.

She handed envelopes to the others and told them the same.

P.: How will the green fit in?

L.: You'll have to fold it. Show me one of sixteen on your green sheet. Show me four of sixteen pieces.

Frank raised his hand.

L.: Does this equal something? 1/4?

L.: Something else?

P.: Two of the eighths.

L.: Show me 8 of 16 pieces.

P.: It equals one of the big white ones.

Fr.: One half.

L.: It equals what else?

Fr.: Two reds.

J*: Four of these eighths.

L.: Get all your pieces and put them in your envelope.

P.: May I go to my desk?

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Observer # 3

L.: Yes, put the envelope in your desk.

11:38. This group left and Ms. L. called up a group that did not finish earlier. They began by cutting the brown sheet.

I left as Juan* was passing out meal tickets.

APPENDIX F

Site H

Description of a Title I Mathematics
Inservice on Introducing Multiplications
to Third Grade Students, January 20, 1981

Description of a Title I Mathematics Inservice on Introducing Multiplications to Third Grade Students, January 20, 1981

The math inservice focused on helping students develop concepts about multiplication. Teachers and aides were divided into 3 rotating groups to learn how to use manipulative aids and games in instruction. Manipulatives themselves were viewed as a kind of language and teachers needed to know how to use this language in teaching students to use the "technology of manipulatives for learning." A packet of materials give to each classroom group to facilitate the teachers' implementation of the activities in the classroom.

> . . .I stayed with the green group with Mrs. Wing (MPS) presiding. We worked with square tiles in rows and columns. Egg cartons work well for counting tiles. This was an introduction to multiplication facts. One way in which we worked with tiles were rows and columns. We were asked to place two tiles next to each other and in three columns. It looked like this ☐ ☐ ☐ .
>
> ☐ ☐ ☐
> ☐ ☐ ☐
>
> Then Mrs. Wing (MPS) made the following on the board as we worked problems.

Rows	Columns	Total
2	3	6
3	3	9
4	3	12

> "Does anyone see a pattern?" asked Mrs. Wing (MPS). An answer was given, "We are just adding 3 more each time." . . .
>
> . . .When manipulatives are used they stimulate language according to Bob Ward, however, Mrs. Wing (MPS) feels they are a language. Because of these tiles, multiplication is seen in a different way. Using multiplication facts in this way called: sign the picture with the number of tiles, sign with 3. The tiles are placed on the squares and answer written where tile was removed.

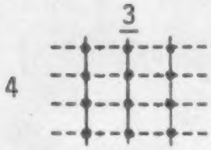
X	1	2	3	4
1	☐	☐	3	
2			6	
3			9	12
4				

Example: 1 x 3 = 3

☐
☐
☐

Lines and Crossing Points was an idea using lines for either rows or columns but not both. Then another set of lines were used to represent the rows or columns and where the lines crossed beans were placed. The counting of beans gave the student the answer. Example:

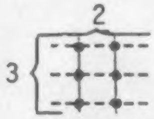
3 x 4 = 12



12 beans so 3 x 4 = 12.

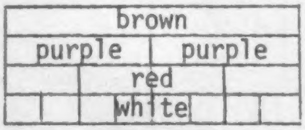
The x sign was called "of the".

This exercise lead into division.



Answer 6

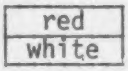
These activities finished at 9:05 and we were told where the tiles could be purchased. At 9:17 we were given another hand out and cuisenaire rods were also passed out. We turned to page 1 (Making One-Color Train) where we did the brown train. We were to place our rods on the graph paper and we made all the one-color trains which matched the brown rod. Then they were removed and drawn on the graph paper. Example:



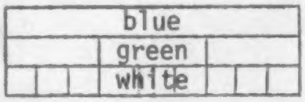
or 8
4 x 2
2 x 4
1 x 8

Brown or 8 was the same as 2 purples with the value of 4 or 4 x 2, or 4 reds with the value of 2 or 2 x 4 = 8, or 8 whites of value of 1 making the equation of 1 x 8 = 8.

At 9:15 page 3 was worked showing how each rod was assigned a number name. Let white = 1. Then red = 2 because red = 2 whites. Several examples were done showing the way to build the multiplication facts using the rods. Several teachers sitting at the table to the right of me, kidded Mrs. Wing (MPS) as she wasn't going to place her whites on the proper spaces. Comments such as: "You sound like the children" "It's too hard." "These are too many" and "I don't want to do it."



Page 4 was begun at 9:20 (Finding Facts for One-Color Trains). We were asked to place our rods on each pattern and build the multiplication facts for each family of one-color trains. Example:



Equations:

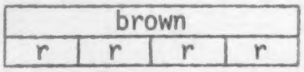
1 x 9, 3 x 3 and 9 x 1

The people present expressed how interesting this train building had been and how easy the children should find multiplication. We continued using rods and using two colors such as orange plus one other color like yellow giving a value of 15 and we made more equations. This was used to express numbers by 'tens' and 'ones.'

At 9:24, we did page 7 which covered all the facts like 20 (orange + orange) 1 x 20 20 x 1. The people present found page 9 interesting as the students were to match the pictures with the products. Example:

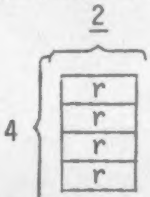
4 x 2 = 8

At 9:25, we came to page 15, which Mrs. Wing (MPS) wanted to be sure was covered today. It was called Changing Trains to Rectangles were white = 1. We found the brown rod could be matched with 4 red rods like this:

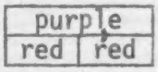


1 x 8
4 x 2

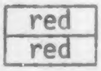
Then it was shown how 4 red rods could be made into a rectangle. The dimensions of the rectangle were 4 x 2. Example:



We did 3 x 4 on page 17 using rods and calling x "of the." Which to page 19 (Finding Square Numbers).



The purple rod could be matched by 2 red rods.



The 2 red rods could be made into a square, 2 x 2. 2 x 2 = 4. 4 is a square number. A puzzle called Square Deal concluded Mrs. Wing's (MPS) presentation.

. . .At. 10:00, Mrs. See handed out a multiplication facts sheet which was colored in by each of us to represent zeroes, ones, twos, fives, nines, perfect square and last 10 facts. We did this in the hall while the red group stayed in the room to hear Mrs. Wing give the presentation given the green group earlier.

As each group of facts was colored Mrs. See (MPS) and Mrs. Jones (MPS) explained and had us play the game that went with each. In some cases an instructional activity was presented instead of a game. A lesson plan chart was also given to each classroom. This time not every one received everything instead each classroom received the hand outs.

Zeroes were explained like a gun and the gun zaps it (number) out so the answer is always 0. One was like taking a picture. Another way to express it was if you know one fact; you know another.

The directions given by Mrs. See (MPS) on using the multiplication facts sheet were: (1) have the students write in the products first and (2) have the students color only the facts studied at that time.

The Game: Backwards Bingo. The first game played by us was called Backwards Bingo. On cards about 4 inches by 4 inches were facts like $\boxed{2 \times 7}$, $\boxed{8 \times 1}$ and $\boxed{3 \times 2}$. After the BINGO cards and 'facts' cards were handed to each individual, you were to cover your card with the 'facts' cards including the two 'FREE' spaces. Colored cards the size of a regular deck of cards had numbers. These numbers were called out; if you had the fact with that answer, a 'fact' card was removed. Right away you knew if you had the right answer as the number showed from your BINGO card. This could go beyond the first person reaching a small BINGO so more facts could be uncovered and for reinforcement.

The Game: Five Up. Five up was another game introduced by Mrs. Jones (MPS). It was played with a colored deck of cards made of multiple of fives in suits of red, green, blue and black. This game was designed for 5-6 children. It is played like One Up and Two Up. A 5 starts the game and the 10 of the same suit would be played next, however, if the 10 could not be played then a 5 of another suit may be played instead. The first person to run out of cards was the winnter. This game was also used for facts by saying 1 x 5 = 5 as the 5 was played.

The Game: Obey the Signs. 10:30 We were working on 'nine' facts. Many things were given at this point such as one less than pattern strategy, look for patterns on multiplication table (what do products begin with), use flashcards (what does answer begin with), strategy--the sum of the products' digits is 9, and finger multiplication. The game taught was Obey The Signs. It had a gameboard, 40 cards and one die. One player shuffled 40 cards and placed them face down in the center of the playing area. The first player turned a card over from the draw pile and gave the answer to the problem. If the player gave the correct answer, the player rolled the die and moved the number of spaces shown on the die.

It was learned that Unifix cubes, tiles, graph paper and rods were good instructional aids used with 'Perfect Squares.'

The Game: Grab the Grudge. The game 'Grab the Grudge' was explained as our last game of the workshop. It was used with the "last 10 facts." This game should not be played until the students had a good multiplication background. . .

. . .At 10:55 we went into the math room to join the red group where people talked with each other. 11:00 Mrs. Smith explained string art and showed some of the work done by her students. Different angles created different designs--even a string boat out of different colors was created.

APPENDIX G

Site I

Invented Worksheets to Teach
Reasoning Behind Common Denominator

Special Report: Fraction Tests
Research Site I

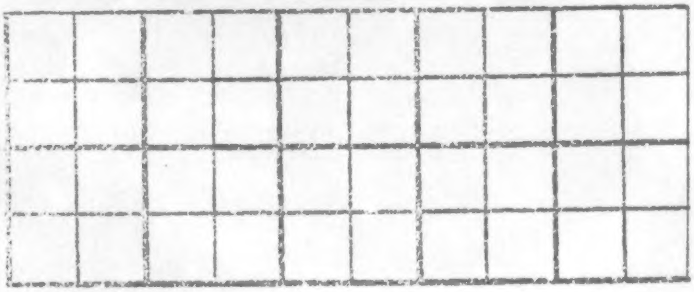
CUISENAIRE ROD FRACTIONS

NAME ______________________

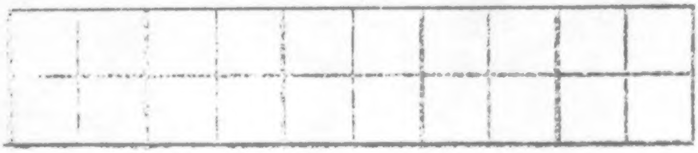
Let the orange rod be one. Make all the one color trains you can that equal the orange rod in length. What fraction of the orange rod is:

yellow ________ red ___________ white __________

We call this the "family of tenths"

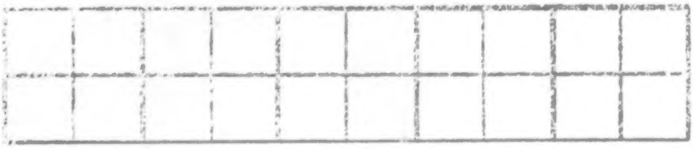


Use Cuisenaire rods to show each addition problem below. Change each fraction to its family name and use that to write the answer!!



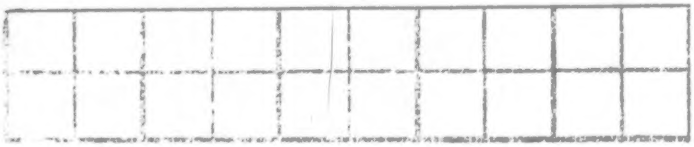
$\frac{1}{2} + \frac{1}{5}$

$\frac{5}{10} + \frac{2}{10} =$ ________



$\frac{3}{5} + \frac{1}{10}$

$\frac{\;}{10} + \frac{\;}{10} =$ ________



$\frac{7}{10} + \frac{1}{5}$

$\frac{\;}{\;} + \frac{\;}{\;} =$ ________

Try these!

$\frac{1}{\;} + \frac{1}{10}$ $\quad$ $\frac{\;}{\;} + \frac{\;}{\;} =$ ______

$\frac{1}{2} + \frac{1}{5} + \frac{1}{10}$ $\quad$ $\frac{\;}{\;} + \frac{\;}{\;} + \frac{\;}{\;} =$ ______

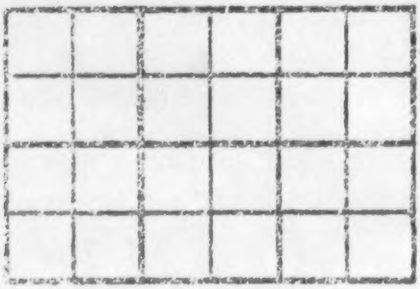
$\frac{3}{5} + \frac{1}{2}$ $\quad$ $\frac{\;}{\;} + \frac{\;}{\;} =$ ______

CUISENAIRE ROD FRACTIONS

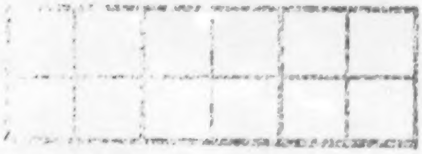
Let the dark green rod be one. Make all the one-color trains you can that equal the dark green rod in length. What fraction of the dark green rod is:

Light green ______ red ________ white ________

We call this the "family of sixths"

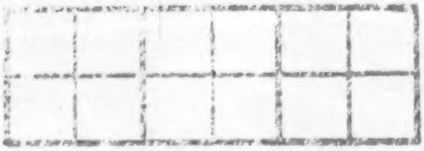


Use Cuisenaire rods to show each addition problem below. Change each fraction to its family name and use that to write the answer.



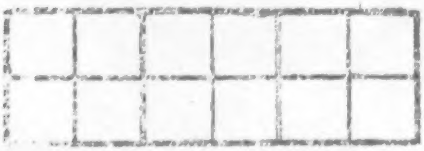
$\frac{1}{2} + \frac{1}{3}$

$\boxed{\frac{3}{6}} + \boxed{\frac{2}{6}} =$ ________



$\frac{2}{3} + \frac{1}{6}$

$\boxed{\frac{\ }{6}} + \boxed{\frac{\ }{6}} =$ ________



$\frac{1}{3} + \frac{4}{6}$

$\boxed{\ } + \boxed{\ } =$ ________

3-26, 27-81
Observer #4

Special Report: Fraction Tests
Research Site I

Mr. Hernandez showed me the results of a fraction test which he had given the class at the end of his unit on fractions, the week before the math specialist came. I was in the midst of an observation, but took some time to make some notes from these test papers, especially those of the target children, and a couple of other "exceptional" papers. Mr. Hernandez also shared the results of the 3-26 test with me the next day. Because of the circumstances of this test, I was not sure if a fair comparison with the first test could be made (see observation for 3-26).

First Test

Bernardo*: 12 correct (of 20) Bernardo had the pattern for fraction addition figured out, but his mathematical details were often incorrect. When he changed the fractions to get the least common denominator, he made such errors as 1/2 = 5/8, 1/2 = 6/10, 7/8 = 56/16, 1/2 = 4/10. Bernardo writes in a very "scribbly" style and does not always have his numbers aligned straight. He is working on this problem with a "special" teacher (LD?).

Bernardo also did not finish the test, which lowered his score.

Miguel : 0 correct. Added the fractions as columns of numbers, e.g.

$$\begin{array}{r} \frac{1}{6} \\ + \quad \frac{2}{3} \\ \hline 12 \end{array}$$

Miguel has been absent frequently while I've been observing the class.

Patty* : 18 correct! One of her errors was from reading 1/12 as 1/2; another was from adding instead of subtracting. All her calculations were correct.

Sylvia* : 17 correct. Her three errors were all in conversion to LCD. Like Bernardo, she has the pattern for fraction addition and subtraction correct. E.g.: 1/3 = 3/2, 2/3 = 10/18, 11/16 = 7/16 (misread?)

Mario* : 8 correct (of 10 completed). Mario seems to have a phobia about long problems; he did only the subtraction problems, which have two fractions, and skipped over the three-fraction addition. (This is the same thing he did on the second test, and was a topic of a conversation he had with Mr. Hernandez during the test.) He did not show his "conversions," only his answers, and left the fraction "line" out of each one. One of his errors was in computation; the other was mysterious:

$$\begin{array}{r} \frac{5}{6} \\ -\ \frac{1}{3} \\ \hline \frac{6}{2} \end{array}$$

Barbara* : 18 correct! Computational errors in her fraction conversion: 2/3 = 10/12, 2/3 = 8/9.

Raquel* : 16 correct. Raquel did not show her work, only her answers. But some of her answers had such large denominators that I wondered if she had a problem with perseveration in this process. Her other errors were computational; she had the process correct.

Alonso* : 18 correct!

Lana* : The only one to do her work horizontally (saves paper?), she did now show her work and had some mysterious errors: 1/3 + 7/12 = 16/12
5/6 + 1/12 = 3/12

Jerry* : 2 correct. I could not see a pattern to his work at all at first, but then realized that he was simply adding or subtracting the numerators without converting them to LCD. He favored the second denominator in the problem as the denominator in his answer:

$$\begin{array}{r} \frac{1}{10} \\ \frac{11}{16} \\ \hline \frac{12}{16} \end{array}$$

Carlos : One of the monolingual children who did not do as well as I expected. These children, according to Mr. Hernandez, are not included in Title I because the test is in English. Carlos might be a candidate if this were changed. He had 3 correct problems.

His errors were that he subtracted instead of added, even when the sign was clear. And he subtracted "up," i.e., took the top term from the bottom term:

Had *this* sign!

$$\begin{array}{r} \left.\begin{array}{r} \frac{4}{12} \\ +\ \frac{7}{12} \end{array}\right) - \\ \hline \frac{3}{12} \end{array}$$

Second Test

These are the results of the test I observed on 3-26. It is interesting to compare the results with the behavioral observations; infact, I don't know if I could have interpreted the results at all without the observation.

The tests showed signs of hurrying, and nobody completed all the problems. I don't think the children were *trying* to sabotage "Miss Arnold," the math specialist (Mr. Hernandez had announced before the test that its purpose was to see if Miss Arnold had helped them with their fractions), but maybe the test circumstances seemed artificial to them. At any rate, the results were hardly comparable to the first test. Considering that they did not finish, most of the target children did as well as before, with the same patterns of so-called "careless" computational errors. Alonso*, who came to class late from orchestra practice, did not do as well as before, but neither did many of the brightest non-target children. Ricardo* and Felicia only got the problems *copied* (see Ricardo's copying difficulties in the observation). Jerry* seemed to have put down *any* answer at random, but he had followed a pattern: adding up the numerators for the answer's numerator and the denominators for the answer's denominator. During the test he had seemed in a hurry to finish so he could play games with Julio. Mario* again skipped over the three-fraction addition and completed 4 of the fraction subtractions in the short amount of time he finally devoted to the test; 3 of these were correct. Mario* seems to avoid difficulty if he can; he has ability when he tries.

Mr. Hernandez shared some of the children's personal histories which he felt related to their school performance: broken homes, many moves, otherwise "upset" family patterns. He said that he tried to make himself available after school for children who wanted to talk about their home problems. He also expressed the opinion that he wished the math specialist could spend more time in the classroom helping the children.